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INDUSTRIALIZATION IN JAPAN, CHINA MAINLAND, AND INDIA — SOME WORLD IMPLICATIONS[1]

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WHEN I received the notification of my designation as Honorary President of the Association, my first reaction was one of great pleasure and gratification. Shortly, however, the same concerns began to rise that have plagued, I am sure, all my predecessors in this honor: What should be the theme of my address? What would be the most appropriate area within the field of geography to develop for presentation on this occasion?

In the days that followed, a line of reasoning gradually began to take a more or less orderly form in my mind. It seemed to me that I must select an area of interest of long standing in which I had concentrated a substantial portion of my research. Preferably, this interest should relate to a part of the world familiar to me by extended field observations. These two considerations pointed directly to East and South Asia. In view of my preoccupation, over more than forty years of teaching, with the economic aspects of geography, an economic approach seemed indicated. My research and my experience in government both suggested economic development, more specifically the process of industrialization. And finally, I had the desire to place my study, whatever its immediate boundaries, in a world perspective. These thoughts, then, led to the topic selected, Industrialization in Japan, China Mainland, and India—Some World Implications.

It is evident at once that we are dealing with three countries quite unlike in many ways. Certainly, they are now in very different stages of industrialization. Japan stands apart. That country has been concerned with modern industry for a relatively long period. It has made notable progress and now ranks among world industrial leaders with preeminence in a number of industries. The other two countries, China and India, have only recently begun active programs of industrial development and their accomplishments are less impressive.

Despite these contrasts, the association of the three countries in a single presentation is both justified and useful. There are many evidences that Japan, with all its progress, is still engaged in the process of industrialization. Levels of productivity and of income are relatively low in comparison with Western nations, the portion of the gainfully employed in primary production, especially agriculture, remains high, and the small enterprise continues to occupy a place of importance in the economy. In these respects, Japan belongs with China and India. In addition, Japan, because of its earlier start and greater progress, may serve in our discussion as a prototype for the other two countries and may give some indication of the probable direction and degree of their development.

It is difficult to emphasize sufficiently the magnitude of the economic developments now in progress in the three countries or to grasp fully the probable impact of those develop-

[1] Address given by the Honorary President of the Association of American Geographers at its 56th Annual Meeting, Dallas, Texas, April 20, 1960. It is based primarily on extended studies carried on in the three countries in 1926–27, 1931–32, 1938–39, and 1957.

TABLE 1.—POPULATION IN EAST AND SOUTH ASIA, 1957[1]

County	Population in millions
China Mainland	640
Japan	91
Korea[2]	31
Vietnam[2]	27
Laos	2
Cambodia	5
Indonesia	85
Federation of Malaya and Singapore	8
Philippines	23
Thailand	21
Taiwan	10
Burma	20
Ceylon	9
India	392
Pakistan[3]	84
	1,448
Other East and South Asia countries	14
Total East and South Asia	1,462
Total world[4]	2,795

[1] Compiled from United Nations, *Demographic Yearbook 1958*, pp. 104, 114–117; United Nations, *Monthly Bulletin of Statistics*, Vol. XIV, No. 5 (May 1960), pp. 1–5.
[2] Data for 1956.
[3] Provisional.
[4] Includes allowance for the population of the U.S.S.R.

ments on the rest of the world. In Japan, China and India live 40 percent of the world's population though in area the countries cover only ten percent of the earth's land surface. If to the three major countries are added the smaller countries of the crescent of East and South Asia, all of which in some degrees are joining in this desire for economic change, more than one-half of the world's population becomes concerned. (See Table 1.) This fact is basic and inescapable. It underlies all my discussion. Whatever may happen economically to so large a portion of the world's inhabitants must have far-reaching effects upon the remainder.

THE PROCESS OF INDUSTRIALIZATION

Economic development in Asia is focused upon the broadening of the base of the national economies. Specifically, it is directed to the effort, through industrialization, to replace agriculture as the dominant activity. This process of industrialization, to my mind, implies not only the establishment of modern factory industries. It includes also the extension of the methods commonly associated with an industrial society to transportation and communications, to the extraction of minerals, to agriculture itself—in fact to all aspects of economic activity. It involves a greater application of capital, mechanical energy, and technology to the production and distribution of goods. The process has as its goal the raising of the level of production per unit of labor. Its success will be measured by the increase in real per capita income over a period of time.

The move toward industrialization points to a fundamental change in East and South Asia. The societies of this area are basically agricultural societies following methods that have undergone little alteration over the centuries. Unless the ratio has been changed in the last few years, something like 80 percent of the economically active in China Mainland are in agriculture.[2] The ratio in India in agriculture, forestry, hunting and fishing at the time of the last census in 1951 was 71 percent, of which all but a very small fraction, two or three percent, was in agriculture.[3] The smaller countries of the crescent have much the same dependence on the land. Even in Japan, the percentage in agriculture at the time of the 1955 census was some 40 percent, a ratio much higher than that found in any major country of the West.[4]

LOW PRODUCTIVITY OF AGRICULTURAL SECTOR

Not only are these societies basically agricultural but the agriculture is characterized by low productivity in terms of human effort even though it may be able to boast of high yields in relation to land area. Readily arable land is the scarce resource. The numbers of the population, large and increasing, have meant individual holdings so small that even under the most intensive hand cultivation the returns to the cultivator have been meager. The demands of the land leave the farmer idle and unproductive for much of the year.

Centuries of dependence on agriculture in these countries of increasing population have

[2] John Lossing Buck, *Land Utilization in China* (Chicago: University of Chicago Press, 1937), chap. XIII, "Population," by Frank W. Notestein and Chi-Ming Chiao, p. 363; Leo Orleans, "The Recent Growth of China's Urban Population," *Geographical Review*, Vol. LXIX, No. 1 (January 1959), p. 45.
[3] United Nations, *Demographic Yearbook 1956*, pp. 361, 367, 368.
[4] Japan, Office of the Prime Minister, Bureau of Statistics, *Japan Statistical Yearbook 1955–56* (Tokyo), p. 58.

led to declining per capita output and to underemployment or concealed unemployment on a large scale. Both are functions of the same underlying relationship, too little land and too many people. As a consequence, agriculture has become a highly inefficient operation in relation to the portion of the population that it employs.

It is impossible to estimate with any degree of accuracy how many workers could be withdrawn from agriculture without any appreciable reduction in the total product, but the number is certainly large. In Japan, the agriculturally underemployed have increased substantially since the close of World War II and may now reach four or five millions.[5] Kingsley Davis has estimated that the number of workers dependent on agriculture in India could be reduced by as much as one-third, even with the present low level of capitalization, with no impairment of output.[6] Such a reduction would have removed almost 25 million from the group classified as agricultural workers in 1951.[7] In China Mainland, the underemployed in agriculture are being organized in great numbers into labor groups for the building of roads, dams, irrigation ditches, and works for flood control.

Under such circumstances, the per capita productivity in agriculture must be low. It is likely to remain low. For the numbers now dependent on the land, there is little opportunity for increased efficiency or for increased per capita output. Any important additions to the area under cultivation will be accomplished only with difficulty and at high real costs. On the land at present in use, the law of diminishing returns will continue to slow down the rate of increase of per capita production unless there is a technological revolution not now in prospect. The numbers added to agriculture each year through population increase will depress efficiency and per capita output still further.

[5] Ayanori Okasaki, *Japan's Population Problem* (Tokyo: Japan Ministry of Foreign Affairs, Public Information and Cultural Affairs Bureau, 1956), pp. 8–12.

[6] Kingsley Davis, "The Economic Demography of India and Pakistan," chapter in *South Asia in the World Today*, edited by Phillips Talbot, Harris Foundation Lectures (Chicago: University of Chicago Press, 1950), p. 96.

[7] United Nations, *Demographic Yearbook 1956*, p. 367.

TABLE 2.—PERCENTAGE OF NET DOMESTIC PRODUCT CONTRIBUTED BY AGRICULTURE AND INDUSTRY, 1956[1]

	Japan	India	China Mainland[2]	United States
Net domestic product at factor cost	100	100	100	100
Agriculture, forestry, hunting and fishing	20	50	48	5
Industry—including manufacturing, construction, mining and quarrying	33	17[3]	32[3]	39

[1] Computed from data in United Nations Department of Economic and Social Affairs, Statistical Office, *Yearbook of National Accounts Statistics 1958*, pp. 47, 104–105, 127–31, 235–41.

[2] Net Material Product, which is defined as the total value of material goods and production services produced in the course of a year. Estimates cover following economic activities: agriculture, mining, manufacturing, construction, transportation and communications, trade and catering. Economic activities not contributing directly to material production, such as public administration and defense, personal and professional services and similar activities, are not included. For these reasons the estimates for China are not comparable in concept and coverage with those of the United Nations system of national accounts.

[3] Includes electricity, gas, water, sanitary services.

One measure of the inefficiency of the agricultural sector and of its limitations is to be found in its relative contribution to national income. In all three countries, agriculture's contribution, as shown in Table 2, is substantially lower than its share of total employment. In contrast, the industrial sector makes a contribution to national income substantially above its share of employment.

With agricultural productivity on a relatively low level and with so large a percentage of the gainfully employed engaged in agriculture, it follows that on a country-wide basis the average per capita productivity, and hence the average per capita income, will be low. Of the three countries, Japan alone has an annual per capita national product above $200, a level substantially below that of the countries of the North Atlantic. The annual per capita products of China and India are much less than $100 and are among the lowest to be found in any part of the world. (See Table 3.) These are conditions shared, of course, with other less-developed areas. Characteristically, the traditional way of life of the great majority of the world's population, with its high degree of dependence on primary production, results in low, static, or declining levels of productivity per worker and in low incomes and low levels of living.

TABLE 3.—PER CAPITA NATIONAL PRODUCT, 1956[1]
(United States dollars)

Country	Amount
Japan	229
India	62
China Mainland[2]	57
United States	2,051
United Kingdom	897
West Germany	673
France	951
Italy	380

[1] Computed from data on net domestic product in United Nations Department of Economic and Social Affairs, Statistical Office, *Yearbook of National Accounts Statistics 1958*, pp. 246–57; currency conversion factors from *Direction of International Trade*, July 1959, pp. 63–64, published jointly by the United Nations Statistical Office, International Monetary Fund, International Bank for Reconstruction and Development (Statistical Papers, Series T, Vol. X, No. 7); population data from United Nations, *Demographic Yearbook 1958*, pp. 110–21.

[2] Data for China Mainland are net material product (see note 2, Table 2). Conversion of yuan into U. S. dollars is at 40 cents U. S., an official rate reported in the *New York Times*, April 22, 1959, "Peiping Increases Arms Budget 16%."

With such low individual productivity, these three countries contribute a relatively minor portion of the world's total production. China Mainland, with nearly 650 million people, apparently has a total net national product no greater than West Germany with 51 million. India, with a population of about 400 million, has approximately the annual national product of Canada with 16 million. Even Japan, with a little more than one-half the population of the United States, has a national product approximately six percent as large.[8] It is evident that China, Japan, and India contribute a share of the world's total annual product of goods and services far, far below their 40 percent of the world's population.

INCREASED PRODUCTIVITY THROUGH INDUSTRIALIZATION

The process of industrialization is essentially an effort to break with an economic order characterized by a low productivity, impossible or difficult to augment. It anticipates the shift of substantial portions of the population from primary production to other activities, specifically manufacturing industry, in the expectation of achieving increased per capita production and thus higher levels of living. It has as its goal something more than the employment of the new manpower generated by the increasing population. There is also the hope that considerable numbers now ineffectively occupied in agriculture may be absorbed and the percentage of the gainfully employed in this sector thus reduced. In their expectation of increased productivity, the Asiatic countries have had the example of the West, and also of Japan, where the industrial sector, much less circumscribed than agriculture by the operation of the law of diminishing returns, has been able to provide both employment opportunities for rapidly expanding numbers of workers and also progressively rising rates of individual productivity.

Industrialization will undoubtedly mean expanding employment, but the prospect of shifting significant portions of the workers from less to more productive activities should be considered with caution. If such a shift could be realized, the numbers involved would be tremendous. If India and China were to reduce their percentage of gainfully employed in agriculture down even to the present 40 percent level of Japan, new employment in manufacture, commerce, and service activities would have to be found for approximately 30 million in India and for many, many times the present number in factory work in China. The necessary industrial expansion would present many difficulties and the shift would be spread over many years.

Any thought of reducing the percentage in agriculture to a point near the level of Western European countries or of the United States introduces such fantastic numbers that the extreme unlikelihood of such an accomplishment becomes obvious. It would necessitate a complete revolution in agriculture with large holdings and much machinery replacing the tiny plots and hand labor.

It is unrealistic, therefore, to anticipate any significant reduction in the absolute numbers of workers engaged in agriculture in China or in India. For an indefinite period they will remain high. Indeed, those countries will be fortunate if capital formation and industrial expansion can proceed at a rate sufficiently rapid to absorb the new additions to manpower. The experience of Japan in the modern period would seem to substantiate such a prospect. From the opening of the country in the middle of the nineteenth century, the

[8] See note 2, Table 2; note 1, Table 3.

absolute number of farm workers has maintained, until the abnormal years immediately following World War II, a constant level of about 14 million.[9] Industrialization has not broken into this hard core. Though it has succeeded in keeping pace with the increasing population and has absorbed the greater part of the new manpower, it has not solved the problem of the underemployed and the unemployed in the rural sector. The result has been a gradual reduction in the percentage of workers in agriculture as the total population has increased.

With the relative rise of the percentage in nonagricultural activities, the over-all average productivity has improved. Agriculture itself has also benefited through some of the accompaniments of industrialization in the form of more scientific methods of cultivation, more effective application of fertilizer, some mechanical equipment, better seed selection, and the use of insecticides, all improvements contributing to greater productivity per worker. The urbanization resulting from industrialization has had the effect of providing a cash market for agricultural products. Funds have thus been made available to the cultivator for the financing of better methods of cultivation.

These same trends are likely to hold also for China and India: expanding manufacturing will strive to absorb the new manpower; the percentage of gainfully employed in agriculture will then drop gradually as total population increases; urban centers will provide cash markets for agricultural produce; more capital will be employed on the land; agriculture will become somewhat more productive; the country's average per capita productivity will rise appreciably; the absolute numbers engaged in agriculture will undergo little change unless the commune organization of Mainland China can bring about more drastic shifts in occupations and in employment than have occurred in Japan.

WORLD IMPLICATIONS OF ASIATIC INDUSTRIALIZATION

Though the achievements of industrialization in meeting all the problems of these massive populations may fall short of goals considered desirable, the effects will nevertheless be profound within the countries themselves and with respect to the world economy. Large numbers will remain in the relatively low productivity of the agricultural sector, but industrialization will introduce some leaven into the economy and the general range of productivity will be higher. If China and India are able to accomplish even the modest improvement in individual productivity achieved by Japan, there will be a substantial advance in incomes per worker and in levels of living. (See Table 3.)

Prospect for Increased Incomes

With the higher incomes in the Asiatic countries, there will be higher capacity to consume, both individually and nationally. New demands will be created for many commodities to be supplied either from domestic production or through import. A contribution will be made to the narrowing of the "contrast of wealth and poverty between . . . Western nations and most of the rest of the world" characterized recently by Adlai Stevenson as the "most important and fateful fact in the world today."[10]

An offsetting circumstance to any prospect of narrowing this contrast is the rapid increase in per capita productivity and levels of living in countries already with high average incomes. There is evidence that the rate of this advance is even higher than is generally the case for the countries of low incomes. (See Table 4.) For example, the average per capita national product of India for the period 1952–54 was $60 and for 1956, $62, an advance of $2. Over the same period, the per capita national product of the United States increased from $1,870 to $2,051 and of the United Kingdom from $780 to $897. Thus the dollar gaps between the per capita national products of India and both the United States and the United Kingdom were actually wider at the end of the Indian First Five Year Plan than at the beginning. Over the same years, Japan fared a little better. As indicated in Table 4, the actual dollar gaps with United States and United Kingdom productivity widened somewhat but the Japanese productivity

[9] Seiichi Tobata, *Japan's Agriculture: Farming Population* (Tokyo: Japan Ministry of Foreign Affairs, Public Information and Cultural Affairs Bureau, 1956), p. 7.

[10] *New York Times*, May 29, 1959, "Stevenson Calls for War on Want," p. 1.

TABLE 4.—RELATIVE NATIONAL PRODUCTIVITY, 1952–54, 1956, 1957[1]

Productivity measure	1952–54	1956	1957
Per capita productivity in U. S. dollars			
India	60	62	
Japan	190	229	255
United States	1,870	2,051	2,096
United Kingdom	780	897	945
Dollar gap—in U. S. dollars			
India with U. S.	1,810	1,989	
India with U. K.	720	835	
Japan with U. S.	1,680	1,822	1,841
Japan with U. K.	590	668	690
Percent of productivity			
India of U. S.	3.2	3.0	
India of U. K.	7.7	6.9	
Japan of U. S.	10.1	11.1	12.2
Japan of U. K.	24.0	25.5	27.0

[1] For source, see note 1, Table 3.

TABLE 5.—COAL PRODUCTION, SELECTED COUNTRIES, 1958[1]
(Million metric tons)

Country	Tons
World[2]	1,761
Japan	50
India	46
China Mainland[2]	270
United States	389
Union of Soviet Socialist Republics	352
United Kingdom	219
West Germany	134

[1] Data from United Nations Statistical Office, *World Energy Supplies 1955–1958* (Statistical Papers Series J, No. 3, 1960), Table 5, pp. 52–54. Does not include lignite.

[2] World estimate includes Union of Soviet Socialist Republics and China Mainland. The estimate for China Mainland is hidden in the total for Asia not otherwise listed and is obviously lower than the 270 million tons officially announced by the Central Committee of the Chinese Communist Party as reported in the *New York Times*, August 27, 1959, "Peiping Cuts '58 Output Figures, Concedes Gross Overstatement."

increased slightly in its percentage of the productivity of the two countries.

It seems evident that the rich are becoming richer. If the poor are not becoming poorer, they are not maintaining a speed of growth that will enable them to better their positions relative to the more fortunate nations. Their difficulty is the great increase in numbers of people. The problem presented by population expansion in relation to rates of economic growth is an extremely important one. It will be considered more fully later in the discussion. At this point, it can only be indicated that the less-developed areas, specifically Mainland China, India, and Japan, if they are to narrow the "contrast of wealth and poverty," must establish a somewhat accelerated rate of economic development.

Increased World Production of Goods

These changes within the three Asiatic countries will have significant implications with respect to the world economy. Whether or not they are able to keep pace with the per capita rate of growth of the Western nations, it seems certain that their total national product will be increased substantially. As a consequence of this increase, the world as a whole will be producing a greater volume of goods and will have more goods to consume.

The Asiatic countries may be expected to attain greater world importance in key manufacturing industries. One measure of their present limited industrial development is to be found in their small consumption of coal, still the world's prime source of mechanical energy. China Mainland, India, and Japan combined, with 40 percent of the world's population, produced in 1958 about 20 percent of the world's total coal output. (See Table 5.) On a per capita basis, the consumption of the three countries is only a fraction of the consumption of the Western nations.

If the level of coal consumption of China Mainland and India were raised only to the present per capita consumption of Japan, which is much lower than that of any of the leading Western industrial countries, the total annual output of the three countries would need to be about double their 1958 output. Such an increase is quite within the realm of possibility. The basic reserves are present. The output required of China, the most likely source, would be not more than 50 percent above that country's reported output. It is likely that the coal production of the three countries will more than double within a very few years and that they will contribute a much higher share than at present to the world total.

In steel, the three countries produced in 1958 less than ten percent of the world total, or little more than the production of West Germany.[11] The story for cotton cloth is quite

[11] United Nations, *Monthly Bulletin of Statistics*, Vol. XIV, No. 2 (February 1960), p. viii; data for China Mainland officially announced in the corrections by the State Statistical Bureau as reported in the *New York Times*, August 27, 1959.

different. As is to be expected, the textile industry has taken the lead in the process of industrialization and the annual production of cloth is substantial. The three countries produced in 1958 about 13 billion meters of woven cotton fabric in comparison with the eight billion meters of the United States.[12] The per capita production of China and India, but not of Japan, was quite small, however, in relation to the United States or other Western countries.

An expansion in these two manufacturing industries, similar to the expansion in coal output, would be a more formidable task and would present more difficulties. The annual production of steel of the three countries, on the basis of the modest Japanese per capita production of recent years, would total some 150 million tons or about six times the present production. To bring their per capita production up to the Japan level, an eightfold increase in the 1958 output of the steel industry of China Mainland would be required and a twenty-eightfold increase for India. In all three countries, the steel producing capacity is being expanded substantially, but certainly not on these scales.

In cotton cloth, the total enlarged production of the three countries would need to be over 36 billion meters in comparison with the present 13 billion. All these estimates are purely speculative but they do give some indication of the magnitude of growth required if these countries are even to approach Western industrial levels. They also suggest the possible impact of such growth on total world production.

Possible Competition with Western Industry

One vigorous and unmistakable reaction to the industrial development of the Asiatic countries has been the fear in the more highly industrialized areas of possible disastrous competition with their established industries. In the cotton textile industry, the competition of Japan has contributed to the downfall of Lancashire. As early as 1932, Japan had overtaken the United Kingdom and had become the world's leading exporter of cotton cloth. In the postwar years, imports of Japanese cotton textiles into the United States have been met with protests and boycotts in some of our Southern states. To counter this opposition, Japan has adopted "voluntary" quotas on textile exports to this country. The threat of the competition of abundant and cheap Oriental labor has moved both the Amalgamated Clothing Workers of America and the joint American Federation of Labor–Congress of Industrial Organization recently to retreat from their former liberal trade positions, on which they had prided themselves, and to advocate restrictions on the import of certain goods, especially textiles and articles of apparel from Japan and Hong Kong.[13]

Without question, the newly developing manufacturing industries of the three Asiatic countries will offer serious competition to some of the established industries of the Western nations. The commercial success of Japan in the prewar years confirms such a prospect. A substantial impact upon Western economies may be expected. Dislocations in industrial patterns will follow and adjustments to meet them will be necessary. Problems such as these will not be solved easily. They should not be minimized. In the long run, however, it is likely that they will be much less significant in relation to the total world economy than the effects of increased productivity and increased purchasing power for 40 percent of the world's population.

Increased Demands on World Raw Material Supplies

If the three countries are able to raise individual productivity and individual consumption and to expand their key manufacturing industries, there will be, of course, corresponding increased demands on the world's supply of raw materials. The probable increase in coal consumption in China and India has been indicated earlier. More iron ore—much more, in fact—more raw cotton, more

[12] United Nations, *Monthly Bulletin of Statistics*, Vol. XIV, No. 2 (February 1960), pp. 44–45; data for China Mainland from "Communique on China's Economic Growth in 1958" (issued by the State Statistical Bureau), *Current Background*, No. 558 (April 20, 1959) (Hong Kong: United States Consulate General). There was no announced correction in the cotton cloth estimates in the statement of corrections issued August 26, 1959.

[13] *New York Times*, July 8, 1959, "Union Would Cut Clothing Imports"; August 17, 1959, "A.F.L.–C.I.O. to Propose 'Sweat Shop' Import Curb"; May 31, 1960, "Union May Boycott Japanese Fabrics."

tin and aluminum and copper and more of the whole list of industrial raw materials will also be needed each year. The world's known resources will be heavily pressed to meet these demands. The search for new sources of supply, both within the three countries and in other parts of the world, will receive new emphasis. More attention even than at present will be given to the use of possible alternative materials, especially those of synthetic origin.

This mention of the probable accelerated drain on raw material supplies is not intended in any way as an alarmist cry on the imminent exhaustion of our industrial resources. It is rather a reminder that in future planning on the utilization of our known and probable supplies a new variable is being added to the formula. It is necessary to think now of a higher rate of depletion arising from the greater demands of 40 percent of the world's population who heretofore have participated to a limited extent in the consumption of many materials.

Reference should also be made at this point to a likely increase in demand for food in these three countries. Both the rapidly growing populations and the anticipated improvement in the levels of living would indicate that more food will be needed. A part of the increase will undoubtedly be met by the indigenous agriculture, but land is the scarce resource and there are limits to the expansion of yields.

It seems reasonable to conclude that as Japan, Mainland China, and India move forward in the process of industrialization, they will become more and more dependent upon the rest of the world not only for their supplies of raw materials but also for foods. East and South Asia may prove to be a significant market for areas of less dense population which lend themselves more readily to large-scale machine cultivation and to low production costs and which are capable of producing food supplies beyond their own needs. Some of these areas, notably the United States, are already plagued with agricultural surpluses and will welcome new outlets.

Prospective Changes in World Trade Patterns

Industrialization and increased productivity in the Asiatic countries will bring about great changes in their relation to world markets and in the pattern of world trade. So many variables enter into trade comparisons between countries that any attempt to express the probable extent of such changes on a quantitative basis can easily lead to unsuspected pitfalls and to misleading conclusions. Certain generalizations on future trends, however, are reasonably safe.

It is evident that the present participation of the three countries in world trade is of minor importance whether it is considered in absolute amounts or on a per capita basis. Japan, China Mainland, and India have contributed only five or six percent to world exports in recent years.[14] This low percentage would be reduced materially if Japan were omitted. That country has gained substantial stature as a trading nation and is responsible for about one-half of the total trade of the three countries. The exports and imports of India and China, with their much greater populations, are relatively quite small. Their economies have been integrated into world trade only to a very limited degree.

It is also evident that substantial increases in the participation of the three countries in world trade may be expected in the years ahead. There will be increased demand for capital goods, raw materials, and probably for food. As per capita productivity increases, individual purchasing power will rise and there will be greater demand for consumer goods, some of which will be imported. The increased imports will depend upon increased exports. With industrialization and increased productivity, there is the expectation of a surplus of manufactures for export on a competitive basis.

The measurement of the probable increases in the volume of trade is both difficult and hazardous. At present, the per capita annual imports and exports of China Mainland and India are among the lowest in the world. (See Table 6.) However successful their programs of industrialization may be, it is not likely that either country, with its great size and varied resources, will equal the Japanese per capita level for many years to come, if

[14] Computed from data in Special Table A, "World Exports by Provenance and Destination, 1956–1958," published in United Nations, *Monthly Bulletin of Statistics*, Vol. XIII, No. 6 (June 1959), pp. viii-xiii.

TABLE 6.—PER CAPITA TRADE OF SELECTED COUNTRIES, AVERAGE FOR 1956–58[1]
(United States dollars)

Country	Imports c.i.f.	Exports f.o.b.
Japan	38.69	30.19
China Mainland[2, 3]	2.01	2.44
India	4.91	3.31
United States	75.01	111.31
Soviet Union[2, 4]	19.53	20.16

[1] Computed from data on trade in United Nations, *Monthly Bulletin of Statistics*, Vol. XIV, No. 5 (May 1960), pp. 96–99; on population, pp. 1–5.

[2] Data for trade of China Mainland and Soviet Union from *Direction of International Trade* (see note 1, Table 3), Annual Issue, Vol. X, No. 8 (August 1959), pp. 167–68, 267.

[3] Two-year average, 1956 and 1957; data for 1958 not comparable.

[4] Soviet Union population estimated for 1957 and 1958 at 203 and 206 million, respectively.

ever. Japan is a small country with limited resources and, like every small country, must depend upon foreign trade to live. Nor is it likely that China and India will ever approach the high per capita trade of the United States with a level of living far above their present or probable future levels. It is conceivable that the trade of the two Asiatic countries may approach the per capita trade of the Soviet Union, another large area. Such an advance, however, would require approximately a fivefold increase in the total trade of India and a ninefold increase for China. These increases, along with the to-be-expected increase in the foreign trade of Japan, would mean a very great expansion in the total volume of world trade.

Other changes in the trade of India and Mainland China will probably be a shift in their exports from the present emphasis on unfinished goods to greater emphasis on manufactured products and in imports from finished producer and consumer goods to raw materials and foods. Such a shift is already evident in the trade pattern of Japan. It would seem to be safe and reasonable to anticipate a more and more intimate integration of the economies of the three countries into the world economy as their industrialization progresses.

Possible Military Implications of Asiatic Industrialization

In any discussion of the world significance of the industrialization of the Asiatic countries, some mention should be made of possible military implications. They can receive only passing reference here, since an adequate treatment would require a close familiarity with modern weapons of warfare and with military strategy.

Certain observations on the military implications would seem to be justified and logical: If the present analysis had been written in the period of conventional weapons at the outbreak of World War II, the possibility of a combination of a strong, modern industrial base with the great populations of Japan, Mainland China, and India would have presented a truly formidable military threat. Japan provided an example of such a combination during World War II. With the introduction of nuclear weapons, manpower in sheer numbers may have been reduced in importance as a military force. But manpower with scientific and technical skill, supported by an advanced industrial system, has become the foundation of military strength. Without much question, Japan, Mainland China, and India, as a consequence of industrialization, will have access within a very short time to nuclear energy for both peaceful and military purposes. These countries must now be reckoned as positive elements in any assessment of the world balance of military strength.

Enough has now been said about probable changes in productivity and consumption and levels of living of a large part of the world's population and about the impact of those changes upon world manufacturing, upon the demand for raw materials and food, upon the world trade pattern and upon the balance of military power to make it abundantly evident that we are considering a development of the first order of importance to the world. I venture to suggest that history may record the industrialization of Japan, Mainland China, and India as the great economic event of the twentieth century just as the Industrial Revolution marked the eighteenth century and the great expansion of world commerce, begun much earlier, marked the nineteenth. In effect, these two revolutionary developments, industrial and commercial, which spanned more than two centuries in their unfolding for the Western world, are now being brought in their full impact, in the brief time space of a few decades, upon the three countries of Asia

with 40 percent of the world's people. The results must be far reaching.

PROBLEMS OF INDUSTRIALIZATION

In my presentation up to this point, there is the implicit assumption that the efforts to industrialize the three countries of Asia will bring a substantial degree of success. This assumption happens to reflect my own judgment but I am fully aware that such success will not be easily won. These countries, with their great populations living at low economic levels, are faced with extremely difficult problems of economic development. Even if the problems can be solved, there is still the question whether the gains of industrialization can be sufficient to bring about any real improvements in the levels of living for the mass of the people.

It would be impossible to discuss within reasonable limits the many problems involved. Accordingly, I have selected just three for examination: The first is the population of the three countries, already huge in numbers and increasing at a rapid rate; the second is the closely related problem of limitations on capital formation; the third is the resource base or the problem of raw materials and energy supply. These three problems, it seems to me, present key difficulties, perhaps ranking above all others. They all have geographic implications. They are common to most underdeveloped areas in the process of economic development.

To meet these and other difficulties, the three countries have chosen quite different approaches in initiating and carrying out their programs of industrialization. These approaches are well characterized in the chapter headings of a recent annual report of the United Nations Economic Commission for Asia and the Far East.[15] The chapter heading for Japan reads "Growth and Structural Change in a Private Enterprise Economy," the Mainland China chapter, "Industrialization in a Centrally Planned Economy," and the one for India, "Planned Development in a Mixed Economy." These contrasting approaches are, of course, of vital interest to the United States. Conspicuous success or failure in any of the countries could have decisive implications in tipping the balance between the noncommunist and the communist worlds.

The Problem of Population Increase

The great populations of Japan, Mainland China, and India are both an asset and a liability. They are an important resource for industrialization. At the same time, they create an extremely difficult problem of capital formation if they are to be employed effectively. These two aspects of the populations are considered in the following sections.

Their numbers assure an abundance of labor for any expansion of manufacturing industry. Their rapid rate of increase assures a continued abundance which will be augmented still further by any changes in techniques releasing more labor from agriculture. With the abundance of labor, the present level of wages is far below the level in the West. It will be difficult to advance it materially against the mass of underemployed and unemployed in the rural areas and the constant flow of new entrants into the labor market from the increasing population.

Not only will the wage level remain low but real labor costs are likely to be low. Japan has already provided ample proof that Asiatic labor is quite capable of acquiring skill and of reaching high levels of efficiency. Also, I have seen in both China and India a sufficient number of modern factories with highly efficient labor forces to be convinced that these workers are not only cheap as far as actual wages are concerned but that they have the potential, given proper organization and equipment, to achieve low levels of labor costs.

This abundant labor supply is without question the greatest single resource for industrialization possessed by the three Asiatic countries. As the major resource, it should be utilized to the fullest possible extent and should occupy a central position in all plans for economic development. Its contribution to increased productivity and to economic growth will depend, however, upon the success of the three countries in mobilizing the necessary capital and the technical and administrative skills to employ it effectively. Machines, power, transportation, construction, skill in their use, organization for the entire complex must be provided, all in vast

[15] *Economic Survey of Asia and the Far East 1957* (Bangkok: United Nations Economic Commission for Asia and the Far East, 1958), 261 pp.

amounts. Otherwise, the labor supply remains largely a wasted asset.

Technical and Administrative Skills

Technical and administrative skills present a serious problem. They may be imported to some extent by the use of foreign experts or they may be acquired by a limited number of individuals through sending them abroad for periods of apprenticeship in more advanced industrial countries. In these two possibilities, Japan has long looked to the United States and Europe. Mainland China is now dependent upon the Soviet Union and the Satellites. India, in her neutralist position, can draw upon both the West and the Communist World.

For the most part, however, these necessary skills must be generated at home within the indigenous populations. They cannot be created over night. Their development may be accelerated by programs of worker training and by any progress that may be made in advancing general education levels. Almost inevitably, though, shortcomings in the possession of such skills remain as a major handicap throughout the earlier stages of any nation's industrialization. Japan has long since overcome the handicap and has attained a high level of competence in technology and administration. Intensified programs of education and training are reported from China. There is less evidence of progress along these lines in India.

Limitations on Capital Formation

The need for capital presents an even more serious problem.[16] The requirements for any substantial degree of industrialization in the countries of Asia are enormous. Estimates of the amount required to provide the planning, training, and equipment for absorbing one individual into nonagricultural employment in an underdeveloped area vary widely. The Economic Commission for Asia and the Far East of the United Nations has adopted for working purposes for its group of countries, excluding Japan, a capital requirement estimate of $1,500 per additional worker. This estimate would seem to be a conservative one. It coincides closely with the estimated capital expenditure per new worker in India's current five-year plan. It is apparently lower than the expenditures in Mainland China. It is certainly much too low for Japan.

If, however, the estimate of $1,500 is accepted as representative and if a continuation of the population increase of the countries of East and South Asia at the present annual rate of 1.7 percent is assumed, then, according to the Commission, the capital requirements to absorb new entrants into the labor force and to make only limited provision for employment of previously unemployed and underemployed would be about 14 percent of the aggregate net income of the countries.[17] This ratio would mean for China and India the withholding from current consumption of almost $10 per capita annually out of each individual's total average income of approximately $65.

Such a rate of saving and capital formation would call for a degree of austerity extremely difficult to reach and so far not attainable in a democracy such as India but seemingly possible, and perhaps already more than accomplished, in an authoritarian state such as China. The rate of capital formation in India during the First Five Year Plan was seven percent per year, one-half of the ECAFE estimated basic requirement. It is expected that it will reach a little more than ten percent in the Second Plan. For Mainland China, the annual rate of capital formation is given as 20 percent of the national income. Services, however, are excluded from China's definition of national income.[18] The capital formation rate would undoubtedly be somewhat lower if the same definition of national income were used as for the other countries. For Japan, annual savings and capital formation are now at the very substantial rate of about 25 percent of national income.[19]

The rate of savings and capital formation

[16] This problem of capital formation in East and South Asia is treated quite fully in a study prepared by the United Nations Economic Commission for Asia and the Far East and published in the United Nations, *Economic Bulletin for Asia and the Far East*, Vol. X, No. 1 (June 1959), "Population Trends and Related Problems of Economic Development in the ECAFE Region," pp. 33–45.

[17] *Ibid.*, p. 36.

[18] *Economic Survey of Asia and the Far East 1957*, *op. cit.*, pp. 99 and 106.

[19] *Japan Statistical Yearbook 1955–56*, Table 230 F, Gross Saving and Capital Formation (1930–1955), p. 398.

presents particular difficulties in the East and South Asia countries. The basic position of agriculture in economic activity, much of it on or close to a subsistence level, the high ratio of population to land, the small individual land holdings, the low per capita productivity of agricultural workers all mean low per capita and national incomes. After living necessities are met, little surplus remains from current income for savings, the mobilization of any such surplus into effective units presents a serious problem, and capital formation becomes a slow process.

Among the three countries, Japan alone has attained a satisfactory rate of accumulation. Over the years, so much progress has been made in industrialization, including improvements in agriculture, and the more productive nonagricultural sectors of the economy have gained relatively such importance that the per capita national income of Japan is the highest among the Asiatic countries. The present high rate of savings has become possible. Even this high rate, however, has not met Japan's needs completely for rehabilitation and expansion since the war. Domestic savings have been supplemented by foreign financial assistance, some from public national or international institutions, some through commercial transactions with foreign corporations and other interests.[20]

In the earlier years of the industrialization process, Japan was handicapped, as China and India now are, by severely limited capital supplies. There was some aid from abroad but principal dependence was placed on the government which, through taxation and through subsidization and other aids to industry, was able to bring together any available small surpluses and direct them into the uses considered to be the most vital in the program of development.

The question of capital supply is one of the most serious problems, if not the most serious, facing both Mainland China and India in their present programs of economic development. Both governments, though motivated by quite different political philosophies, have taken leading roles in meeting the shortage. Mainland China has received financial aid from the Soviet Union and from some of the Satellite states in the form of equipment and technical assistance. Undoubtedly of greater importance have been the savings of the Chinese people though these savings may not have been contributed voluntarily. Bond drives have been used to absorb some surpluses. Grain collections have placed large supplies of rice and wheat and other staples in the hands of the government at low prices to be resold at substantial profits. The political and social changes since 1949, including such measures as the nationalization of industry, the campaigns against private enterprise with the resulting confiscations and penalties, the state control of trade, the reorganization of the agricultural sector through the stages of the land reform, the collectives and the communes, have all served to place the means of production and the national income completely under the control of the government. This control over income permits a gigantic mobilization of all possible savings for allocation only to uses considered to be in accord with national goals. It is one way of meeting the problem of capital shortage in a land of low per capita production. It has apparently resulted in a relatively high rate of capital formation in Mainland China. It may seem to be an effective way if one is able to overlook the individual human values involved.

India, unable to employ some of the more direct methods that are being made use of in Mainland China, has had to depend upon voluntary savings and upon taxation supplemented to a much greater degree than in China by loans and investments from abroad.[21] There has been recourse to some extent to one form of forced savings in the deficit financing of a portion of each of the five-year plans and in the drain of income from consumers through the resulting inflation and price rises.

India's efforts in capital formation from domestic sources have fallen short of needs. The rate of savings, as has been noted, is very low and it would seem unlikely that it can be increased materially in the near future though there will undoubtedly be intensified efforts

[20] *Japanese Industry 1958* (Tokyo: The Foreign Capital Research Society, c/o The Bank of Japan), pp. 105–106.

[21] Government of India Planning Commission, *Review of the First Five Year Plan* (New Delhi, 1957), pp. 30–35; *Second Five Year Plan* (New Delhi, 1958), pp. 77–78.

to mobilize greater savings out of any initial increases of income resulting from economic development. Still greater dependence on financial assistance from abroad would seem to be both necessary and desirable, particularly in these earlier stage of industrialization, if per capita incomes are to be increased sufficiently to permit a rate of domestic savings more commensurate with India's need for capital.

India and China, and even Japan to a somewhat lesser extent, share the predicament of most underdeveloped areas. Is there any possibility of breaking out of the circle of low productivity, low incomes, limited savings, low rate of capital formation, slow expansion of the means of production, continued low productivity and continued low incomes? The situation in all three countries is further aggravated by rapidly increasing populations. The population of Japan is not expected to begin leveling off until its peak of about 108 million is reached around the year 1990.[22] If present trends continue, the current population of a little less than 400 million in India may nearly double within the next 30 years.[23] China's population of 650 million, according to some estimates, is expected to reach one billion as early as 1980.[24] In all these countries, the numbers that should be absorbed annually in the gainfully employed over the next two or three decades have already been born and their need for capital has already been established.

If numbers were static, the solution to the dilemma might not be a difficult one. In time, the capital supply could be accumulated to accomplish the shift of workers into the nonagricultural occupations, for capital once created continues to be productive for many years. An increasing population, however, calls for an ever-accelerating rate of capital formation. Populations expanding in absolute numbers and at the rate of the Asiatic populations compound the difficulty.

Here is the critical question in the future of the Asiatic countries. In the race between population on the one hand and technology, organization, and capital formation on the other, can capital formation keep pace with and perhaps exceed population increase or will these great populations continue to be employed ineffectively? Unless their productivity can be increased, present poverty will simply be multiplied by the degree of population increase. Productivity, in the long run, can be increased materially only by supplementing human effort with mechanical energy and machines. These instruments of production can be provided only if sufficient capital can be accumulated from current income.

This task of capital formation is indeed a formidable one. It is extremely doubtful whether it can be accomplished at the rate demanded. Certainly at present, the economies of China and India, and even of Japan, are seriously undercapitalized. In that sense, the great resource of an abundant labor supply is partially a wasted asset since its potential for production is not being fully utilized.

None of the current development plans envisages full employment of the new entrants into the working force, plus the numbers now unemployed or underemployed, unless the mass utilization of labor in public works in Mainland China can be considered to be full employment. India's Second Five Year Plan, it is expected, will provide full-time jobs for only 80 percent of the new entrants into the labor force. It will not cut into the backlog of underemployed.[25]

None of the plans has set, even as an ultimate goal, a level of per capita income approaching the level of income of the Western industrial nations. Improvement of levels of living is thought of in more modest terms of a doubling of present per capita income within the next decade or so. At the present rate of savings, India will require 25 years or more to achieve such a goal. Japan expects to double per capita income in about 15 years.[26] For Mainland China, it is difficult to make any forecast on probable changes in per capita income because of the uncertainty

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[22] Irene B. Taeuber, *The Population of Japan* (Princeton, New Jersey: Princeton University Press, 1958), p. 386.

[23] United Nations Department of Economic and Social Affairs, *Future Population Estimates by Sex and Age, Report IV, The Population of Asia and the Far East, 1950–1980*, p. 10.

[24] *Ibid.*, p. 25.

[25] Government of India Planning Commission, *Second Five Year Plan, op. cit.*, pp. 109–124.

[26] United Nations, *Economic Bulletin for Asia and the Far East*, Vol. X, No. 1 (June 1959), p. 37.

on the real rate of savings. It seems likely that the period required for doubling will be longer than for Japan and shorter than for India.

Devices for Offsetting Shortages of Capital

To offset the shortages of capital, various devices are being resorted to in the three countries. These devices all have as their purpose the spreading of the available supply of capital over the maximum number of workers. This result is being achieved in China by the mass organization of the surplus labor for the construction of public works. They employ relatively little capital. They substitute plentiful labor for scarce capital. In the roads, the dams, the drainage ditches, and the irrigation facilities that result, they are in effect agents of capital formation.

Also in China, the recent emphasis on small-scale enterprises in the steel, machinery, and other industries employs more labor-intensive methods and less capital with the shorter periods of construction, smaller overhead costs, and lesser dependence on transport facilities to move raw materials and finished products. The interest in the small enterprise may be an evidence, too, of a shortage of the skills required in the operation of a large establishment.[27]

The mass mobilization of labor on such a scale requires, in addition to considerable organizational skill, a ruthless use of power. Such ruthlessness is possible in a totalitarian state such as China. More democratic methods are necessary in India. There the surplus labor is being utilized on a voluntary basis in community projects for the drilling of wells and for the expansion of irrigation facilities. In agriculture, labor-intensive methods of cultivation are being introduced to obtain greater yields of rice per acre.

An even more striking evidence in India of the desire to spread scarce capital over more labor is to be seen in the tendency in both the First and Second Five Year Plans to encourage small-scale and cottage industries at the expense of the large-scale establishment. One school of thought, impressed by the great need to provide employment for the increasing population, considers as incompatible with that goal the emphasis on the modernization process which substitutes inanimate energy and the machine for human effort.[28]

Such reasoning is undoubtedly in part a heritage of Gandhian economics with its stress on finding some occupation for the underemployed villager even to the extent of reviving the highly inefficient spinning wheel. It also reflects a real questioning of India's ability to accumulate the capital for modern industry as rapidly as it will be needed for the absorption of the annual additions to the working force. It has resulted in an effort to spread the limited available capital over more labor by substantial allotments in the budgets of both plans to the encouragement of labor-intensive small-scale and cottage industries. There has been legislation restricting the expansion of large enterprises in some industries. India's present interest in the smaller enterprise is undoubtedly motivated also by the decidedly limited availability of technical and administrative skills.

There are evidences even in Japan of a scarcity of capital and of its spread over as much labor as possible. Striking features of the economy are the importance and the persistence of the smaller enterprise in the midst of large establishments and the presence in the laboring force of great numbers of family workers.[29]

These devices for meeting the shortage of capital may be effective to a degree but it is highly questionable whether they are compatible with sound long-term plans for development. The intensive utilization of manual labor through mass organization or through small-scale industry may provide employment for more individuals and thus meet one of the great problems of the Asiatic countries. If better methods of organization are introduced, the level of productivity may even be raised.

It will be possible, within limits, to increase total national productivity. It seems doubtful, however, whether any significant increase in

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[27] "Premier Chou En-Lai's Report on China's Economy," *Current Background*, No. 590 (September 9, 1959), pp. 3–4.

[28] Government of India Planning Commission, *Second Five Year Plan*, pp. 47–49, 429–41.

[29] Japanese Government Economic Planning Agency, *New Long-Range Economic Plan of Japan (Fy 1958-Fy 1962)* (Tokyo, 1957), pp. 49–50; Japanese Government Economic Planning Agency, *Japanese Economic Statistics*, Bulletin No. 11 (August 1959), p. 75.

per capita productivity and income can be expected from the mass utilization of labor or from the perpetuation of small-scale industry. To accomplish these ends, tools of production and power must supplement human effort. If a primary goal of the plans for economic development, the improvement of individual levels of living, is to be realized, there seems to be no escape from the eventual need to provide substantial additions of capital in the form of energy applications and machines.

Resource Base for Industrialization

The two problems discussed so far, the large and rapidly increasing populations of the Asiatic countries and the limitations on capital accumulation, relate to the human element in the industrialization equation and to its effective utilization. The third problem concerns the material base of industrialization and the adequacy of available supplies of energy resources and of the raw materials for manufacturing industry.

The importance of the resource base should not be minimized. Neither should it be considered as the determining or limiting factor at the present time in the progress of industrialization. Other factors, particularly capital availability, technical and administrative skills, are more critical. Japan provides a good example of the secondary significance of resources. That country, the most poorly endowed of the three Asiatic countries, entered upon an active program of industrialization much earlier than either of the other two and has made infinitely greater progress. Aside from raw silk, coal for the most part unsuitable for metallurgical use, very limited petroleum resources, small reserves of iron ore of low quality, a little copper and sulphur, some forest products, Japan possesses few raw materials for industry.[30]

The scarcity of resources has been, of course, a handicap to Japan. It has shaped the Japanese economy and its development. It has necessitated a high degree of dependence on the importation of a long list of commodities including such items as coking coal, petroleum, iron ore, tin, bauxite, salt, raw cotton, raw wool, vegetable oil, crude rubber, timber, and wood pulp. It has contributed an element of high real costs to Japanese manufacturing either through such importations, especially of the more bulky commodities, or through attempts to exploit inferior domestic supplies.

Poverty of resources has placed Japan in the category of have-not nations. It was advanced as one reason for Japan's expansion to the adjacent Asiatic mainland with its supplies of coking coal, iron ore, salt, vegetable oil, and forest products. It has stimulated in the postwar years an interest, less aggressive, in the development of new raw material sources under Japanese commercial control in many distant lands. Alaska is being looked to as a possible source of coking coal, timber, and wood pulp. Arrangements are being made for the development of iron ore supplies in India and in Portuguese Goa. Concessions have been obtained for the exploitation by a Japanese company of the crude oil resources beneath the offshore waters of the Neutral Zone between Saudi Arabia and Kuwait. Negotiations have also been reported with Indonesia on petroleum development.

Japan will continue to be dependent upon imported supplies of raw materials. That dependence will continue to shape the Japanese economy. It will be a handicap. It will emphasize the need to expand exports in order to provide the foreign exchange for balancing the imports. It will place a premium in industry on a high level of efficiency and low processing costs. It will probably direct Japanese manufacturing more and more toward highly fabricated articles requiring little raw material and representing the investment of considerable capital and the application of much skilled labor.

Neither China nor India can be said to be outstandingly rich in physical resources. Both, however, are much more fortunate than Japan in their endowment of industrial raw materials. With their greater areas and their wider ranges of climate, surface features and soils, they are capable of producing a variety of agricultural raw materials quite beyond the potential of a small island country.

India has vegetable oils, hides and skins, natural rubber, and among the fibers, raw cot-

[30] John E. Orchard, *Japan's Economic Position: The Progress of Industrialization* (New York: McGraw-Hill Book Company, Inc., 1930), pp. 260–91; Edward A. Ackerman, *Japan's Natural Resources and Their Relation to Japan's Economic Future* (Chicago: University of Chicago Press, 1953), 655 pp.

TABLE 7.—WORLD COAL RESERVES ESTIMATES, SELECTED COUNTRIES[1]
(Billion metric tons)

Country	Anthracite, bituminous, sub-bituminous	Lignite, brown coal	Total	Percent of world total
United States	1,325	495	1,820	36.3
Soviet Union	998	202	1,200	24.0
China Mainland	1,011	1	1,012	20.2
Germany	280	57	337	6.7
United Kingdom	172		172	3.4
India	62	3	65	1.3
Japan	16		16	0.3
World total	4,155	854	5,009	100.0

[1] Source: United States Geological Survey, *Coal Resources of the United States*, Circular No. 293, October 1, 1953.

ton, jute, and raw wool. China has raw silk, cotton, wool, hides and skins and in the peanut, soy bean and tung tree, sources of vegetable oil.

China possesses one of the world's largest reserves of coal, ranking apparently with the United States and the Soviet Union (Table 7). Some of it is of coking quality. There are numerous iron ore deposits scattered over the country. The extent of the reserves is still uncertain and much of the tonnage has a low iron content. Resources for aluminum production are known to be large. China has had a leading world position in the production of tungsten and antimony. There are deposits of mercury, manganese, lead, and zinc. In the Southeast, the mining of tin has been carried on for many years. Salt is produced both from evaporation of sea water and from the brine of wells.[31]

India ranks among the world leaders in reserves of iron ore. The ore is extremely rich in iron content and much of it is easily accessible to surface mining. Reserves of coal are much smaller than the reserves of China but larger than Japan's. They are concentrated in one area in the northeastern part of the peninsula. The tonnages of coking coal are limited and care should be exercised in their utilization. India is one of the world's principal sources of manganese and mica. There are extensive deposits of bauxite and chromite. India possesses the basis for the development of nuclear power in one of the world's principal known deposits of thorium and in substantial reserves of uranium.

Deficiencies in Energy Resources

In energy resources, China has by far the strongest position of the three countries. The substantial coal reserves have been noted. It is true that they are concentrated mainly in the northern tier of provinces. There is, therefore, the problem of transporting bulky fuel to other parts of the country or of developing alternate sources of power.

In addition to the coal, the water-power potential is considerable. China is a country of rugged topography. Rainfall in much of the area is moderate to heavy and there are numerous streams. Power plants were built by the Japanese on the Yalu and Sungari rivers in Manchuria. At least the facilities on the Sungari have been rehabilitated and are now being utilized. With the completion of the Sanmen Gorge, Liukia and Yenkuo Dams, this year and next, the harnessing of the Yellow River will have been begun.[32] On the Yangtze Kiang, there are numerous power sites, including the gorges near Ichang, which have long attracted the attention of hydraulic engineers. China Mainland is reported to be pushing plans for the development of these power resources. During the First Five Year Plan, 630,000 kilowatts of hydro capacity were added. Large projects now under construction and to be completed in the next two or three years will bring into use nearly four million kilowatt capacity. It is expected that hydro power will contribute 28 percent of the total power of the country by 1962 and 40 percent by 1967 in comparison with nine percent in 1949 and 18 percent in 1953.[33]

As yet, petroleum has not occupied an important position in China's energy resources. Low-grade oil shales were exploited by the

[31] John E. Orchard, *op. cit.*, pp. 292–338; United Nations Department of Economic Affairs, *World Iron Ore Resources and Their Utilization, 1950*, pp. 66–67; Li Szu-Kuang, "Current Geological Work in China," *Current Background*, No. 573 (May 13, 1959), pp. 10–14.

[32] Wang Hua-Yun, "Harness the Yellow River to Benefit Scores of Millions of People," *Current Background*, No. 582 (June 2, 1959), pp. 13–15.

[33] Huang Yü-Hsien, "Development of Hydroelectricity Enterprises," *Current Background*, No. 443 (April 2, 1957); Huang Yü-Hsien, "Construction of Hydroelectric Power Industry is Advancing with Big Strides," *ibid.*, No. 583 (June 3, 1959), pp. 20–23; Fu Tso-Yi, "The Big Leap in Water Conservancy and Electric Power Construction," *ibid.*, No. 599 (October 23, 1959), p. 23.

Japanese in Manchuria. Producing oil wells were drilled at Yumen in Kansu Province during World War II. Since then other discoveries have been made in Sinkiang and in the Tsaidam Basin. There are extensive areas of promising sedimentaries in northwest and west China and exploration work is reported to be going on actively. Extravagant claims on reserves have come out of China, but production has apparently fallen below the goals set in China's five-year plans.[34]

Japan has the weakest energy base of the three countries. Though coal reserves are sufficient to continue production for many years, the seams are deep and disturbed and mining conditions are increasingly difficult. Mining costs are mounting and, as a result, imported petroleum is replacing coal in many uses, including large thermal power plants. Reference has been made to the inadequacies of the coal for metallurgical purposes and to the dependence on imported coking coal. Japan's petroleum resources are negligible. Intensive exploration during recent years has indicated little promise of any significant increase in proven reserves.

Japan does have substantial water-power resources. Hydro power is very important to Japanese industry but this energy source is not capable of much expansion since the potential has already been developed in large part, especially at the lower-cost sites. It is significant that in the plans for the expansion of electric generating capacity in the period 1957–62, 60 percent of the increase is scheduled for thermal plants.[35] They will depend, it is likely, more and more on imported petroleum, thus adding to Japan's balance of payments problem.

Japan is already experiencing a power shortage. Curtailment in the consumption of electricity is frequent in the larger industrial cities in periods of low water flow. It will be difficult and costly to expand generating facilities of conventional types to meet the increasing needs. It is likely that Japan will be among the first of the industrial nations to turn to the development of nuclear power. Already, agreements have been concluded for the importation and erection of the first commercial reactor. It is to be located at the village of Tokai, not far from Tokyo, and is to be completed in 1963. Orders were placed in London early in 1960 for a ten-year uranium fuel supply for this plant.[36]

India's energy problem will be not so much the inadequacy of total resources but the location of these resources within the country in relation to centers of consumption.[37] Coal reserves are concentrated in the northeastern part of the peninsula not far from Calcutta. Long rail hauls are necessary to Bombay, Ahmedabad, and other industrial centers. There is some production of petroleum in Assam but as yet no important discoveries have been made. Recently, it has been reported that discoveries of petroleum have been made, with the assistance of Russian technicians, in western India in the vicinity of the Gulf of Cambay.[38]

The development of the water-power resources in the streams flowing from the Himalayas and the Western Ghats and in the major streams of the peninsula has scarcely begun. It will undoubtedly be pushed vigorously in the future, especially in connection with multiple river projects. The area of distribution for the hydro power is even more restricted than for coal.

Because of these factors of location and distribution, a power shortage is developing in parts of India. It is expected to mount as industrialization progresses. To meet it, India, like Japan, is interested in nuclear power. There are three research reactors in operation or nearing completion. Plans are being made for the construction of the first nuclear power plant. It is to be located between Bombay and Ahmedabad and will supply electricity to both cities. The plant is to be completed in 1965 and will have a capacity of 300,000 kilo-

[34] Wang Chih-Chün, "The Petroleum Industry in the People's Era," *ibid.*, No. 599 (October 23, 1959), pp. 49–53; Li Jen-Chun, "The Present Task of Petroleum Industry," *ibid.*, pp. 46–48; *New York Times*, January 23, 1960, "Red China Reports 31% Rise in Output of Key Goods in 1959."

[35] *New Long-Range Economic Plan of Japan (Fy 1958–Fy 1962)*, *op. cit.*, "Report of the Energy Committee," p. 110.

[36] *New York Times*, December 23, 1959, "Atomic Power for Japan."

[37] H. J. Bhabha, "On the Economics of Atomic Power Development in India and the Indian Atomic Energy Programme," *The Advancement of Science*, December 1957, pp. 159–75.

[38] *New York Times*, May 17, 1960, "More Oil is Found in Western India."

watts. It is expected that the cost of the power will be comparable with present costs in new thermal plants in west and south India.[39]

It is significant that within recent weeks official delegations from both the Soviet Union and the United States have visited India to explore possibilities of collaboration in the development of peaceful uses of atomic energy. It has been reported that India has accepted an offer from the Soviet Union for the construction of the first commercial reactor.[40]

It seems probable that energy resources may present something of a problem in India, Japan, and even in coal-rich China, at least on a regional basis. The prospects are, however, that nuclear power will provide the solution and that economic development need not be hampered by an energy shortage. It is also probable that the raw material base will not be a serious limiting factor in the industrialization of the three Asiatic countries. Japan has long since adjusted to the need to import. The other two countries are more generously supplied though they are by no means self-sufficient. They must depend to some extent on imports. This dependence is likely to be increased.

In the two countries, some domestic sources of mineral raw materials, utilized at present, may prove to be marginal, as has already been the case in Japan. Such sources will be high-cost producers. Their continued exploitation, as demand rises, may call for the application of proportionally greater and greater increments of labor and capital. Like land, they are subject to diminishing returns with a resulting deterioration of individual productivity. To offset this trend, to achieve the desired increase in over-all per capita product and incomes, to avoid high costs for industrial raw materials, it may be necessary for these countries to shift more and more of their populations from the areas of primary production, including both agriculture and mining, into other economic activities more responsive to intensification where labor and capital may be used more effectively. Such a shift will mean a greater dependence upon the import of food and raw materials; it will make necessary the development of competitive exports, probably of manufactured goods; it will lead to a closer integration of the economies of China and India into the world economy.

If the increased dependence on imports does materialize, all three countries have unusually favorable locations with respect to possible sources of supply. They are part of the great crescent stretching from Japan to the Mediterranean which has long been a major world source, perhaps the leading source, of primary commodities. The industrial areas of North America and Northwest Europe are dependent on this crescent for a long list of materials, including crude rubber, vegetable oils, fibers, petroleum, tin, and numerous other minerals. Within the crescent is the world's leading region of surplus rice production. The three Asiatic countries have much closer proximity to these primary producers than do the countries of the North Atlantic. There is here the basis for a complementary economic relationship in the exchange of manufactured goods for the raw materials.

EVALUATION OF PROGRESS OF INDUSTRIALIZATION

In this analysis of the industrialization of Japan, China Mainland and India, there remains the evaluation of progress. What have been the significant characteristics of the programs adopted by each of the three countries? How successful have they been in meeting difficulties and in overcoming the obstacles to economic change? To what extent have programs been translated into accomplishment? What seem to be the prospects for the future?

Japan

Japan's success with industrialization has been considerable despite the handicap of limited natural resources. This success stems very largely from the peculiar genius of the people — their capacity for work, ability to learn, talent for organization and administration, and a remarkable self-discipline. It has been achieved under private enterprise though government encouragement has always been important.

[39] *India Economic Newsletter*, Vol. 1, No. 9 (March 1959), p. 8; No. 10 (April 1959), p. 4; Vol. 2, No. 1 (August 1959), p. 5; No. 2 (September 1959), pp. 6–7; No. 4 (November 1959), p. 5; No. 7 (February 1960), p. 6 (Washington, D.C.: Information Service of India, The Embassy of India); *India News*, Vol. 5, No. 9 (May 1, 1960), "Development of Atomic Energy Program," p. 3 (Washington, D.C.: Information Service of India, The Embassy of India).

[40] *New York Times*, March 8, 1960, "Russians to Build India Atom Plant."

In the prewar period, Japan had already reached a degree of development materially beyond her Asiatic neighbors. She had a leading place in the textile industry and had developed a substantial and effective heavy industry sector. Much of this industrial structure was destroyed in the war and when the war came to an end, production was down to one-third of prewar levels.

With the cessation of hostilities, recovery was swift. By 1950–51 production in manufacturing and mining was back to the prewar figure and in 1956 it was more than double the 1934–36 level.[41] Electric power generation in 1956 reached three times the prewar total. Crude steel output was nearly half again as much as the wartime peak. Postwar Japan has risen to fifth place in world steel production, passing France for the first time in 1959.[42] In 1956 Japan took first place in the tonnage of ships launched and has continued to hold that place against the competition of the United Kingdom and West Germany. The former world preeminence in cotton textiles has been regained. In other industries, particularly in precision instruments, cameras, lenses, electronics and similar labor-intensive but modern items, Japan is becoming a leading producer.[43]

In accomplishing the expansion of industrialization, basic changes have occurred in the structure of the economy. The industrial processes have become more advanced. More kinds of industry have developed. There has been a shift from light goods to heavy producer goods. Labor has become more productive per unit of time employed. One measure estimates an increase of 39 percent in productivity over prewar practices.[44] Real wages have risen, but at the same time wage costs per unit of output have been lowered substantially.

In this modernization movement, there is more emphasis on large-scale enterprises but the small and medium-sized establishments still provide employment for a very large part of the industrial labor force. About one-half of Japan's industrial workers are employed in manufacturing establishments of less than 50 workers. The very large-scale modern establishments of over 200 workers employ about one-third of the workers.[45] Japan's dilemma is to rationalize the small-scale enterprises without destroying opportunities for employment. During this developing period, the small enterprises are used as an aid and a supplement to large-scale industry to cushion ups and downs of the economy.

Japan has drawn up a Long Range Economic Plan, the aim of which is to achieve the maximum rate of economic growth consistent with continuing economic stability.[46] It is not a simple plan and requires complicated adjustment of factors for both long- and short-term results. Unlike the plans of China and India, the Japanese plan does not set up absolute targets of production, but attempts to provide guide lines for the developing economy, leaving as much freedom as possible to private enterprise. The fundamental objective of the Japanese plan is essentially the same as for the Chinese and Indian: that is, to create opportunities for fuller employment of the population and to provide for improvement in the level of living.

The Japanese employment goal is fourfold. It seeks to provide for the new additions to the labor force each year as they reach the working age, and this part of the goal is for the most part being met. The second objective is to shift into modern industry from agriculture some of the self-employed and some of the underemployed family workers now representing 97 percent of the agricultural workers. A third aim is to absorb into more productive full-time paid employment the underemployed and unpaid family workers in the small and medium-size industrial

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[41] Japanese Government Ministry of Finance, *General Survey of the Japanese Economy*, September 1, 1957, Tables 25 and 26.

[42] *Japan Statistical Yearbook 1955–56*, pp. 177 and 192; *Japanese Economic Statistics*, September 1959, Bulletin No. 12, p. 8; United Nations, *Statistical Yearbook 1958*, pp. 237–38; *New York Times*, February 1, 1960, "Japan's Steel Output Gains."

[43] *Oriental Economist* (Tokyo), Vol. XXVIII, No. 591 (January 1960), p. 33; *Japanese Industry 1958*, *op. cit.*, p. 37; *New York Times*, January 13, 1959, "Japanese Attain Electronics Lead"; *World Telegram and Sun* (New York), February 18, 1959, "Japan Retains Lead as Shipbuilder."

[44] *Economic Survey of Asia and the Far East 1957*, *op. cit.*, p. 46.

[45] *Japan Statistical Yearbook 1957*, p. 158.

[46] *New Long-Range Economic Plan of Japan (Fy 1958–Fy 1962)*, *op. cit.*, pp. 11–12.

establishments. The fourth is to abolish unemployment as far as that is possible.

To these ends, it is hoped to create five million additional jobs for paid workers in the secondary and tertiary industries in a period of five years, and in the same period to decrease the total number of family workers in both agriculture and industry by nearly two million. These goals, as difficult as they are to achieve, still leave 12 million persons in the category of family workers — most of them in agriculture. The Japanese goals are not impossible, but they will not be easily accomplished.[47]

In any assessment of Japan's economic development, there is always the puzzling question why Japan moved ahead in industrialization so much earlier and so much more rapidly than did either China or India despite the country's conspicuously poorer endowment of raw materials. What accounts for the greater accomplishment? It is a question that calls for much more study than it has as yet received. I have some ideas which I have developed elsewhere.[48] Some of them are decidedly geographic.

As between Japan and China, it seems to me that one possible explanation of the differing responses to early Western influence may be found in the insularity of Japan and the continentality of China. In the one case, the impact and the pressure of the West could be felt throughout the country, no part of which is many miles from the sea. In the other case, the contact was at most a peripheral one confined to a relatively small part of the population living along the coast. Also, a huge continental mass, with its variety of climates, surface features, soils, and resources, could have much greater confidence in its self-sufficiency than could a small, island country of decidedly limited resources. China, with its size and with its going economy, could afford to be complacent and aloof. Japan, small and weak, was impelled to accept what the West had to offer and to utilize it as quickly as possible as the best means of creating national strength.

[47] *Ibid.*, pp. 57–61.

[48] John E. Orchard, "Contrasts in the Progress of Industrialization in China and Japan," *Political Science Quarterly*, Vol. LII, No. 1 (March 1937), pp. 18–50.

China Mainland

In ways quite different from Japan, China Mainland is now achieving success with industrialization. The rate of economic growth in the first ten years of the Communist regime has been truly phenomenal.[49] In the decades when Japan was pushing her economy toward industrialization, modern industry in China developed haphazardly, mainly in the coastal areas and under foreign influence, but it spread and grew inevitably and by the time of the Japanese invasion, there was a substantial beginning of modern industry, much of it built by the Japanese.

Following their take-over of the government in 1949, the first task of the Communists was the rehabilitation of this industrial structure. Much of the equipment had suffered destruction and deterioration under wartime conditions. Production was at a very low point. The Communist government acted quickly to reconstruct existing facilities. Within three years, by 1952, national production was reported to be back to prewar levels.

From rehabilitation, the government moved into the First Five Year Plan. The inherited industrial capacity served as the basis for a substantial and rapid increase in production. The lion's share of new capital investment was directed into building heavy industry. Very little consideration was given to consumer goods industries or to agriculture. A major concern of the Communist leaders during this period was the elimination of private enterprise and the establishing of state control over all forms of economic activity, large and small, including manufacture, agriculture and trade, extending even to handicraftsmen and peddlers.

The Second Five Year Plan has continued to give top priority to heavy industry, with perhaps a little more attention to agriculture, and to the expansion and consolidation of state control over the economy.[50] The emphasis has been upon increasing production and strengthening the state. Improvement in

[49] *Economic Survey of Asia and the Far East 1957*, *op. cit.*, pp. 106–109; "Premier Chou En-Lai's Report on China's Economy," *Current Background*, No. 590, pp. 1–12.

[50] "Proposals on the Second Five Year Plan for the Development of National Economy," *Current Background*, No. 413 (October 5, 1956), pp. 33–46.

the well-being of the people comes second. Some of the new construction of the First Plan has come into production in the Second Plan period. Increases in output have been substantial.

By 1958, China had risen from obscurity in steel production to seventh place among the world's producers, above Belgium, Italy, Poland, and Czechoslovakia.[51] In coal, the country now appears to be one of the leading producers, ranking close to the United States and the Soviet Union and above the United Kingdom.[52] The generation of electricity is less impressive, being in 1959 less than half the total for Japan.[53] Many new industrial products are being produced for the first time in China during the Second Plan period. They include various kinds of steel, machinery, generating equipment, and airplanes. Over the range of industry, the progress has been uneven, primarily because of the preoccupation with the development of heavy industry. Many major industrial and agricultural targets have been realized three years ahead of the schedule for the Second Plan.[54]

Though emphasis in both plans has been placed on large-scale enterprise, there is still dependence upon small and medium-sized establishments to meet many of the day-to-day needs of the economy. Such establishments can be brought into production more quickly than the larger plants. They require for their operation less technical and administrative skill. They may demand a greater expenditure of labor per unit of output but they represent a smaller investment of capital. They can be distributed more widely over the country and are able to use simple local methods and materials. They thus place less burden on the transportation system for the movement of raw materials and of finished goods.

This combination of emphasis on the development of large, modern installations and continued dependence on the more traditional small establishments is the much-publicized policy of "walking on two legs." It explains in part, at least, China's substantial success in moving forward in production during this period of transition from the old to the new. The spectacular program of building thousands of small blast furnaces throughout the country is an example of the policy. Warnings have been issued, also, not to amalgamate small factories and shops more than is necessary because they can be made to serve the many-sided needs of society. In the same vein, handicraft trades are encouraged to increase the variety and improve the quality of their products. These small undertakings are being used to supply a substantial part of the national production while the large industrial projects are being created.

It is officially claimed that in the reorganization of the Chinese economy, unemployment has been completely wiped out. In fact, there is frequent mention of a shortage of labor in the rural areas. This development is a startling one. It may be essentially true. Organized modern industry has provided only two or three million new jobs each year in the past ten years. But tens of millions of unemployed and underemployed and of displaced persons have been absorbed in the mass labor operations on dams and water conservancy projects and other large-scale public works undertakings. As Chou En-Lai has said, "For a long time to come, the main field for labor will still be on the land."[55]

India

Progress in India has been less spectacular than in either Japan or China Mainland. At the end of the war, there existed a wide variety of modern industrial undertakings of moderate size dependent to a large extent upon British equipment and British managerial and technical direction. Much of the capacity had

[51] United Nations, *Monthly Bulletin of Statistics*, Vol. XIV, No. 2 (February 1960), pp. 54–55; for Mainland China, "Premier Chou En-Lai's Report on China's Economy," *Current Background*, No. 590, p. 8.

[52] United Nations Statistical Office, *World Energy Supplies 1955–1958* (Statistical Papers Series J, No. 3, 1960), Table 2; for Mainland China, *New York Times*, August 27, 1959, "Peiping Cuts '58 Output Figures, Concedes Gross Overstatement" (Communique of Central Committee of the Chinese Communist Party).

[53] For Japan, *World Energy Supplies 1955–1958*, *op. cit.*, p. 117; for Mainland China, *New York Times*, January 23, 1960, "Red China Reports 31% Rise in Output of Key Goods in '59."

[54] "Premier Chou En-Lai's Report on China's Economy," *Current Background*, No. 590.

[55] "1957 Session of National People's Congress—Chou En-Lai's Report on Work of the Government," *Current Background*, No. 463 (July 2, 1957).

deteriorated under wartime conditions. The Indians, like the Chinese, had been apathetic for the most part during the early decades of the century to the possibilities of the Industrial Revolution.

The great awakening to the promise of industrialization came with independence in 1947. Since then, two five year plans have been implemented and a third is being formulated.[56] In the First Plan, particular attention was given to agriculture and public works. In the Second Plan, more emphasis is being placed on capital and producer goods industries with priority to steel and other heavy industries. In both plans, the concern of a democracy for the consumer is evidenced in many ways in decided contrast with China's program.

These plans have expanded production in all sectors of the economy and have opened up many new industrial activities. They are revolutionizing life in India, but at a moderate pace. The targets are modest — much more modest than similar goals in China's plans. Where China has set a target of 10 to 12 million tons of steel for the Second Plan, India's Second Plan goal is six million tons. For electricity generated, India's goal is a little more than one-half the Chinese target, and for chemical fertilizers about two-thirds. The coal target is very considerably under the Chinese aim.[57]

Even these modest goals are straining the Indian economy. Domestic savings have not met investment needs and substantial dependence has had to be placed on financial and other aid from abroad. Total foreign aid to date is probably over three billion dollars and the hoped-for aid in the Third Plan is estimated at over five billion dollars additional.[58]

Numerous important industrial targets, including the steel and cement output, will probably not be fully achieved by the end of the Second Plan. Such failures to meet targets do not mean that the plan has failed or that the goals will not be reached eventually. In many respects, the First and Second Plans represent a preparatory, take-off period for industrialization during which productive capacity is being created and has not come into full operation. The expectation is that production will catch up with the targets. On that expectation, the Third Plan is being drawn in much more ambitious terms than either of the earlier plans.

In India, as in Japan and China Mainland, the most serious problem is the rapidly increasing population and the need to expand employment. The Second Plan is apparently not keeping pace with the growth of numbers. More unemployment is anticipated at the end of the plan than existed at the beginning and no appreciable inroads will have been made on the great volume of underemployment.[59] As a consequence, the Indian planners face a dilemma. There is the pressure to attain greater per capita productivity through the use of power and machines in large-scale modern industry. There is also strong sentiment for the spreading of employment through the encouragement and perpetuation of small traditional industries and the village handicrafts. This conflict is as yet unresolved.

India's economic planning, like her political attitude, may be said to be neutralist. Industries of basic and strategic importance and public utilities are to be the exclusive responsibility of the state. Other essential industries and those requiring large-scale investment will become progressively state-owned. At the same time, however, the state expects private enterprise to supplement its efforts in such areas. The remainder of the economy is left to private enterprise.

The result is a mixed economy, partly capitalistic and partly socialistic. Thus far, the major contributions to increased production have come from the private sector of the econ-

[56] Government of India Planning Commission, *First Five Year Plan* (New Delhi, 1952), xvi, 671 pp.; *Second Five Year Plan, op. cit.*, xiv, 653 pp.; "Third Plan Draft Allocations Made Public," *India Economic Newsletter, op. cit.*, Vol. 2, No. 9 (April 1960), p. 1.

[57] Government of India Planning Commission, *Second Five Year Plan, op. cit.*, pp. 58–60; *New York Times*, December 30, 1959, "Big Steel Plant Opened in India"; January 1, 1960, "Russians Pushing India Steel Mill."

[58] *India Economic Newsletter*, Vol. 1, No. 12 (June 1959), "Third Plan Investment Seen Large," p. 2; Vol. 1, No. 13 (July 1959), "Foreign Capital Seen Vital in Years Ahead," p. 3; Vol. 2, No. 9 (April 1960), "External Aid Needs for Next Decade," p. 1.

[59] *India News*, Vol. 4, No. 11 (June 15, 1959), "Doubling Per Capita Income in Future Plans," p. 3; *India Economic Newsletter*, Vol. 2, No. 4, Supplement 8 (November 1959), "The Economic Development of India," by B. K. Nehru.

omy. The large-scale undertakings of the state, expected to increase capacity greatly in the future, are only now beginning to come into production. They have not yet met the test of sustained output.

Each of the three countries has reacted to the problems of industrialization in a characteristic way. The Japanese talent for adaptability has permitted that nation, under free enterprise, to retain the important aspects of the traditional civilization and at the same time to absorb wholeheartedly the techniques of the West. China, under Communist rule and strong central planning, has chosen to destroy the old culture and to cut all restraining ties in favor of an alien philosophy and an alien economic order. India is attempting to draw upon two worlds, capitalist and communist, and to make the transformation to a new order without the sacrifice of the traditional economy or the adoption of a new culture.

Whatever the outcome of these three approaches, the changes within the three countries in the next generation are bound to be of the first order of magnitude. They will alter drastically the way of life of the indigenous populations. They will have a far-reaching impact on all the world.

EPILOGUE

Here, in Japan, China Mainland, and India, is a laboratory for the economic geographer of magnificent proportions. It presents an infinite number of absorbing problems all inviting his study. If he is interested in man's utilization of his environment in meeting his economic needs, particularly if he is interested in changes in that utilization over time, a case study is unfolding for him in the three countries of East and South Asia and in their neighbors on a scale and with a speed never before witnessed in history.

More than half of the world's people are entering upon the task of altering, within a brief span of years, relationships with their surroundings that have persisted for centuries. Land and agriculture as the bases of economic life are giving way to energy sources, industrial raw materials, machines, manufacturing industry. Fundamental changes in the way of life of millions of people are inevitable. The level of productivity of the individual should be higher. His level of income should be improved. More goods will be produced and more goods will be consumed.

There will be changes in the occupations and in the patterns of distribution of the populations. Particularly, greater urbanization may be anticipated. Cities, numerous and large in size, will replace the village and rural life of the present. There will be changes in land use, and mineral and power resources will take on a new significance. Large modern factories will appear where only handicraft industries are to be found today. New patterns of trade routes and of trade flow will develop.

Remote, almost isolated in the past, East and South Asia is being drawn, both by economic forces and by the revolutionary improvements of recent years in means of communication, into more intimate contact with the other continents. These three major countries will look to other lands for capital equipment and for raw materials and food. They will also be seeking markets for the products of their new manufacturing industries. Their economies will become much more closely integrated with world economies. Their new industries are even likely to create competition with the established industries of older industrial areas.

It seems likely that the whole relationship of this area with the rest of the world will be altered drastically. In world affairs, the countries of East and South Asia have thrown off their former colonial status. They are taking on a new economic, political, and military importance. Their role in world events will henceforth be a positive, not a passive one.

DEVELOPMENT AND GRADING OF DUNES IN WESTERN KANSAS[1]

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Problems of dune genesis have long engaged the attention of physical geographers, as well as workers in other disciplines. During the last 20 years in particular a wealth of papers has been published on the relationships between dune form and orientation and wind regime, covering a great variety of dune types in desert and coastal regions.[2] Notably few geographers, however, have concerned themselves with the nature of the sand grading relationships of dunes. Yet a knowledge of such relationships may well be as necessary to an understanding of the mechanics of dune growth as is information on wind regimes.

Much of the work to date on dune sand grading has been with desert dunes. In his pioneer study, *The Physics of Blown Sand and Desert Dunes* (1941), R. A. Bagnold reported on the gradings of barchanes and longitudinal dunes in the Libyan Desert, postulating that the fine crest-coarse trough gradings of the latter might hold true for longitudinal dunes elsewhere.[3] Carroll and Crocker, however, showed that in the Simpson Desert of Australia this relationship was reversed, coarser peak diameters being found on the crests than in the inter-dune troughs.[4] These contrasting results are discussed in part in my study of a small field of dunes in the western part of the Sydney Plain in Australia, especially with respect to the gradings of the source sands, the size and spacing of the dunes, the distance of sand movement, and the time span of dune growth.[5] Further differences and complications of gradings on barchanes, longitudinal and other dune types of the Ergs of Algeria and Fezzan have been given by Bellair, who found that longitudinal dunes typically have more than two peak diameters in the grading—an observation quite contrary to those of the writers already cited.[6] The reasons for these differences have by no means been fully defined. Indeed, for the Sahara Desert alone, Alimen has noted that the grain-size grading relationships of Saharan sands are so complex that it would be difficult to establish general relationships between grain-size grading and dune type.[7]

Before any generalized theory of dune grading can be developed a great deal of work needs to be done in different environments with dunes of many types and sizes, of different ages, supplied with source sands of widely disparate gradings, and built up under dissimilar wind regimes. These are only the most obvious of the many factors which are known to play some part in the gradings of dunes. The role of vegetation is an additional complication which must also be examined in both humid coastal regions and in the semiarid desert border lands. Very little is known of the effect on dune gradings of different densities of vegetation cover during the progress of dune building.[8]

[1] This study was supported by the Research Fund of the University of Kansas. Grateful acknowledgment is made to Dr. H. T. U. Smith, of the University of Massachusetts, for a critical reading of the manuscript; to Dr. Frank Foley (State Geological Survey of Kansas) and Mr. V. C. Fishel (United States Geological Survey) who made the power auger available for the borings south of Holcomb; and to Mr. W. N. Lockwood of the Garden City office, U.S.G.S., for his help in the field.

[2] Many of the most significant papers have appeared in two journals: the *Geographical Journal* and the *Travaux de L'Institut de Recherches Sahariennes.*

[3] London: Methuen, 1941.

[4] See D. Carroll, "The Simpson Desert Expedition (1939) Scientific Reports. No. 2, Geology—Desert Sands," *Transactions, Royal Society of South Australia,* Vol. 68, No. 1 (1944), pp. 49–59; also R. L. Crocker, "The Soil and Vegetation of the Simpson Desert and Its Borders," *ibid.,* Vol. 70, No. 2 (1946), pp. 235–58.

[5] D. S. Simonett, "On the Grading of Dune Sands Near Castlereagh, New South Wales," *Journal and Proceedings of the Royal Society of New South Wales,* Vol. LXXXIV (1951), pp. 71–79.

[6] P. Bellair, "Sables Désertiques et Morphologie Éolienne," *International Geological Congress,* 19th, Algiers (1952) Section VII, "Deserts Actuels et Anciens," pp. 113–18.

[7] Henriette Alimen made this remark in the course of comments on the paper by Bellair, cited above.

[8] S. A. Harris, "Differentiation of Various Egyptian Aeolian Micro-Environments by Mechanical Composition," *Journal of Sedimentary Petrology,* Vol. 28, No. 2 (1958), pp. 164–74. Harris comments on the necessity for studies on dunes in coastal areas which have a thick cover of vegetation.

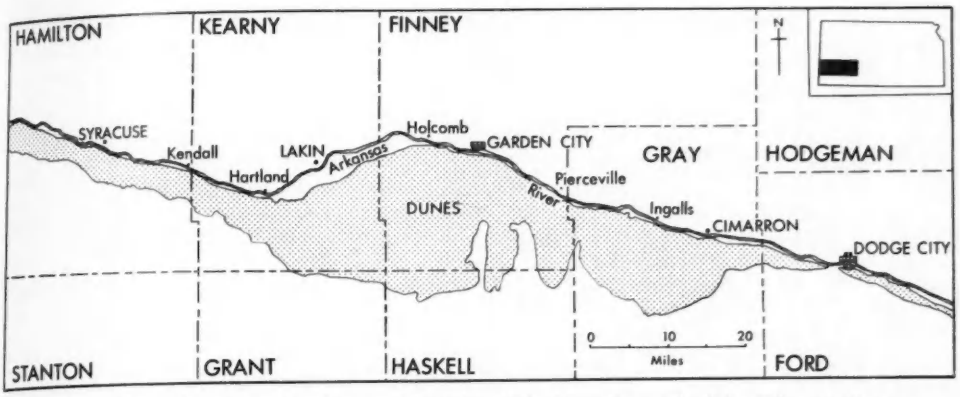

FIG. 1. General location of study area. Note that all the dunes lie south of the Arkansas River.

Of all the climatic environments in which dune grading studies have been carried out, perhaps the most neglected have been those of the mid-continent steppes. However, it is probably in just such areas, characterized by a discontinuous grass and low shrub cover, that some of the most complex dune types and possibly some of the more complex dune gradings might be expected to occur. It was with this thought in mind that the grass-covered dunes between Cimmaron and Syracuse in western Kansas (Fig. 1) were selected for the present study. These dunes were described in 1940 by H. T. U. Smith who concluded that they were complex dunes built up under the continuous influence of vegetation during multiple periods and directions of sand movement.[9] On the basis of Smith's evidence it was considered that these dunes would enable the first steps to be taken in building a picture of the grain-size grading relationships of complex, vegetated, steppe-region dunes.

This study falls naturally into two parts. First, the development of the dunes is considered in detail in order to define with some assurance the location of the source sands, the directions of sand movement, and the function of vegetation in dune growth. Second, an interpretation of the grading relationships of the dunes is given, taking into account both their genesis and the results and speculations of other grading studies.

[9] "Geologic Studies in Southwestern Kansas," *Bulletin of the University of Kansas*, State Geological Survey of Kansas, Bull. 34, Vol. 41, No. 18 (1948), pp. 1–212.

DEVELOPMENT OF THE DUNES

Dune Alignment

As shown in Figure 1, the dunes all lie south of the Arkansas River, in a band ranging in width from 4 miles near Syracuse to 20 miles south of Garden City. The highest dunes rise 70 feet above adjoining troughs, but most are considerably smaller. Those near Syracuse are from 20 to 30 feet high.

The Garden City dune belt consists of a northern and a southern group of high dunes, respectively closest to and most distant from the Arkansas River. They are 40 to 60 feet high, and are generally closer to the lower rather than the higher of these elevations. In between lies an extensive sweep of medium (20 to 40 feet) and low (less than 20 feet) dunes. Most of the dunes are quite short, being only 100 yards to one-quarter mile long. Only rarely are they as much as a mile in length.

At ground level the dunes give an impression of complete chaos. Smith observes: "On aerial photographs and mosaics . . . minute details of form are distinctly shown and some pattern may be distinguished. Forms are forked, hooked, corded, pitted, looped, reniform, amoeboid and irregular. Patterns are reticulate, nucleate and jumbled, they range from coarse to fine."[10] In addition, the mosaics give an over-all weak impression of

[10] *Ibid.*, p. 154.

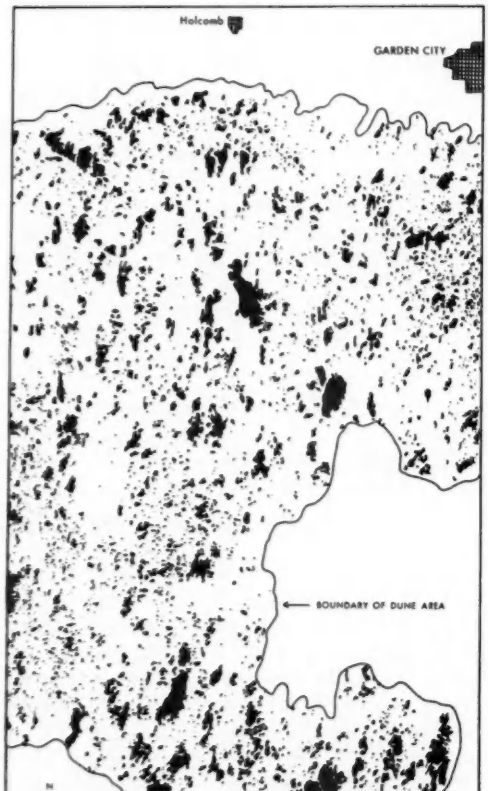

FIG. 2. Inter-dune depressions south of Garden City and Holcomb. Depressions are shown in black. A weak tendency to alignment of the dunes in south-southwest to north-northeast direction may be seen.

dune alignment in a south-southwest to north-east direction, that is, paralleling the southerly to south-southwesterly winds of summer.

To test this impression of lineation in the dunes, a map of interdune depressions was constructed (Fig. 2) for the area south of Garden City and Holcomb by shading in all areas bounded by depression contours, as given in unpublished advance United States Geological Survey topographic survey sheets.[11] While no striking lineation of the troughs is evident, there is a clear tendency to a south-southwest to north-northeast trend, especially

[11] The advance topographic sheets are at a scale of 1:24,000, with a contour interval of 10 feet.

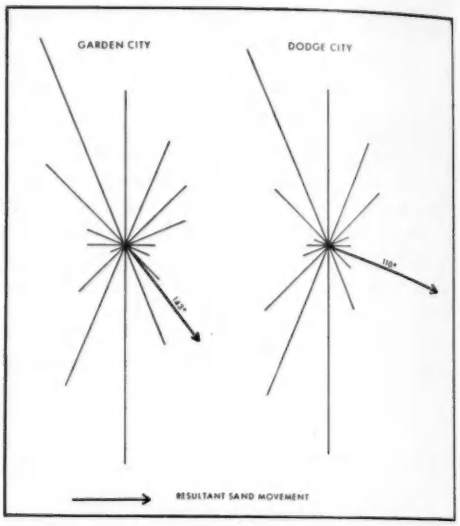

FIG. 3. Vector diagram of assumed sand movement by winds, Garden City and Dodge City.

in the northern and southern belts of high dunes. The multitude of small spot depressions produced by blowouts, many along crest lines, complicate but do not obscure the general alignment. In those areas where free-moving unvegetated dunes are found, especially west of Syracuse, the dunes are of the transverse and barchanoid types, with the steep slip slope facing north; they thus indicate movement towards the Arkansas River in response to southerly winds. Also present in the Syracuse area are occasional fresh-appearing parabolic or upsiloidal dunes with the arms opening to the south. Smith's earlier conclusion that "the effective sand moving winds of the present time, contrary to opinions previously stated, are predominantly southerly," is confirmed by these observations.[12]

This conclusion—that southerly winds are the major present-day sand-moving winds—may be examined further with the aid of a wind rose of apparent sand-shifting capacity on which is given the calculated vector resultant of sand movement (Fig. 3), employing the method devised by Bagnold[13] and exten-

[12] *Op. cit.*, p. 167.

[13] R. A. Bagnold, "Sand Formation in Southern Arabia," *Geographical Journal*, Vol. 117 (1951), pp. 78–86.

TABLE 1. RELATIVE TRANSPORTING POWER OF WINDS AT GARDEN CITY[1] AND DODGE CITY,[2] KANSAS

Wind direction	Transporting Capacity, by Wind Velocity Groups (in mph)[3]									
	Garden City					Dodge City				
	13–24	25–31	32–46	47+[4]	Total	13–24	25–31	32–46	47+	Total
N	3.9	5.7	12.4	1.7	23.7	4.5	8.7	10.2	No Data Available	23.4
NNE	4.8	5.2	6.3	–	16.3	4.8	6.2	5.1		16.1
NE	3.9	3.8	4.6	–	12.3	2.5	3.7	5.1		11.3
ENE	2.9	2.0	4.6	–	9.6	1.7	1.2	–		2.9
E	2.3	1.5	0.7	–	4.5	1.7	1.2	–		2.9
ESE	2.2	1.4	–	–	3.6	2.0	1.2	–		3.2
SE	4.8	1.5	0.7	–	7.0	3.6	1.2	–		4.8
SSE	9.6	5.4	0.3	–	15.3	6.5	3.7	–		10.2
S	10.0	13.9	8.5	–	32.4	11.6	14.9	5.1		31.6
SSW	4.7	7.7	10.0	–	22.4	7.7	11.1	5.1		24.0
SW	2.7	2.0	4.4	0.8	9.9	3.6	5.0	5.1		13.6
WSW	0.9	0.6	0.3	0.8	2.6	1.7	2.4	–		4.1
W	1.7	1.4	2.2	–	5.3	2.2	1.2	–		3.4
WNW	1.9	1.0	3.2	–	6.1	1.4	1.2	–		2.6
NW	2.7	2.9	9.5	1.7	16.8	2.8	3.7	5.1		11.6
NNW	2.9	7.9	21.2	0.8	32.8	3.1	7.4	20.7		31.2

[1] For the period February 1943 through November 1944.
[2] For the period May 1943 through July 1945.
[3] Transporting capacity is obtained from the following formula:
$T = n(y-10)^3$, where T is the transporting capacity; n is the percentage of annual recordings of winds in each velocity group above 12 mph, given as a percentage of all winds exceeding 12 mph; and y is the weighted mean wind speed for the various velocity groups.
[4] Assumed weighted wind speed is 50 mph.

sively used by Landsberg.[14] The nearest available wind recording station for which data have been tabulated by the United States Weather Bureau is Garden City and the next nearest is Dodge City, about 60 miles east of Garden City (Fig. 1). The data for Dodge City cover the period May 1943 through July 1945 and are employed along with those for the Garden City area as a check on the reliability of the data for Garden City, which unfortunately cover only the period February 1943 through November 1944. Since this portion of western Kansas is not an area of rapid transition in wind regime, and the high plains, free from topographic barriers, allow full play to the regional winds, it is considered that the Dodge City and Garden City data should be very similar if both are reliable.

Bagnold has shown experimentally that in the absence of vegetation the effective sand-moving capacity of the wind varies as the cube of the wind velocity in excess of 10 miles per hour.[15] Empirical evidence is also available from a study by Landsberg on coastal dunes in Denmark and Great Britain, and from another study by Jennings on King Island off the coast of Tasmania, that a grass and low shrub cover, *per se*, does not preclude the use of Bagnold's law as a guide to the sand-driving potential of winds.[16] It thus seems reasonable to use this formula in the present study. Application of the formula to the annual summary of winds for Garden City and Dodge City gives the results shown in Table 1 and Figure 3. Since the calculated resultants of sand movement for the two stations differ by almost 35°, it would appear that the records are too short for reliable

[14] See S. Y. Landsberg, "The Orientation of Dunes in Britain and Denmark in Relation to Wind," *Geographical Journal*, Vol. 122 (1956), pp. 176–89. Valuable comments on the difficulties of applying the Bagnold-Landsberg method of computing sand movement are contained in J. N. Jennings, "On the Orientation of Parabolic or U-Dunes," *Geographical Journal*, Vol. 123 (1957), pp. 474–80.

[15] Bagnold, *The Physics of Blown Sand . . . , op. cit.*, p. 69: "The sand flow varies as the cube of the excess of wind velocity over and above the constant threshold velocity at which the sand begins to move." The threshold velocity was shown by Bagnold to be 10–11 mph when the wind velocity was measured one meter above the sand surface. The height at which the velocity is measured is important in that velocity increases with elevation. It is not known at what height the measurements were obtained at Garden City and Dodge City, and the calculations are thus in error by some undetermined amount. However, the error is likely to be constant for all directions and may reasonably be ignored.

[16] See Landsberg, *op. cit.*, and Jennings, *op. cit.*

conclusions to be drawn about the rose of sand movement.[17] Nevertheless, it is probably fair to conclude that the two sand movement roses suggest that the strong but infrequent winter winds from the northwest and north-northwest would be more significant sand movers than the summer southerly winds, and further that the resultant of all winds would give a general drift towards east by south to southeast. Neither suggestion accords with present experience either on the free dunes or on the vegetated dunes. It may well be that frozen ground and snow accompanying the winter storms appreciably reduces the effectiveness of northerly winds as sand movers. The well-known northerly blizzards of western Kansas undoubtedly figure large in the above calculations (Table 1), since high winds, even though of short duration, have a disproportionately large potential for driving sand. Nevertheless, though the contributions of northerly winds to sand shifting must be partly discounted, some blowouts are produced by the north winds of winter, and the complexity of dune form in western Kansas is undoubtedly a reflection of this seasonal near-reversal of wind direction.

Source of the Dune Sands

Since the area south of the dune sands consists of a near-continuous loess mantle from 3 to 10 feet in thickness it seems clear that a source to the south is quite improbable, as the loess contains only very small quantities of the coarser grades of sand characteristic of the dunes.[18] Two possibilities remain: a source directly beneath the sands, or a northerly source composed of Pleistocene terrace sands and gravels along the Arkansas, with perhaps contributions from the Arkansas alluvials.

Thick Pleistocene terrace gravels and sands underlie the dunes in the northern part of the Garden City dune belt. The latest of these terraces is probably Wisconsinan, although an Illinoian age is indicated for some of the higher terrace remnants by vertebrate fossils of *Citellus richardsonii* (Sabine).[19] Latta reports that south of Garden City a thickness of 37 feet of terrace gravel and sand was encountered in one test boring, and of 68 feet in another near Cimarron some 30 miles to the east.[20] He believes further that "the terrace extends nearly to the southern edge of the dune sand" in the Garden City area and clearly implies that it forms a direct source immediately under the dunes for the entire dune field. Smith says:

> It is probable that the sand was derived at least in part from the terrace deposits, but it is uncertain whether dune building took place when the present terrace was still a part of the flood plain or after down cutting to a lower level. Toward the southern part of the dune belt there was probably a different source or sources of sand. At different places the sand may have been provided by older and higher terraces, as yet unrecognized, or by Rexroad or Kingsdown sands, or simply by denuded slopes cut in the Ogallala formation.[21]

For the southern part of the dune belt these suggestions of a source directly beneath the dunes may be partially correct. In Figure 4 are plotted 21 locations south of Garden City where loess from 2 to 12 feet thick directly underlies the sands, as shown by hand and power augerings and exposures in dune troughs and quarries.

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[17] It would be preferable to have wind data covering at least a five-year period, since one or two violent storms within a relatively short time span may have an undue influence on sand-shifting capacity, and hence introduce a sizable bias in the vectorial analysis.

[18] Loess samples collected south of the dunes usually contain rather less than 0.5 percent of sand larger than 0.50 mm. in diameter. The dune sands average (on the basis of almost 80 samples) almost 5 percent larger than 0.50 mm. in diameter. Grades of sand this coarse tend to lag behind on sand movement. Hence the loess region cannot be the source since the proportion of coarse sand is *less* than in the dunes.

[19] See J. C. Frye and A. B. Leonard, "Pleistocene Geology of Kansas," *University of Kansas Publications*, State Geological Survey of Kansas, Bulletin 99 (1952), p. 121. Also B. F. Latta, "Geology and Ground-Water Resources of Finney and Gray Counties, Kansas," *University of Kansas Publications*, State Geological Survey of Kansas, Bulletin 55 (1944), p. 179. Latta also lists fossil remains of elephant, horse, bison, squirrel, and prairie dog found in Garden City gravel pits.

[20] Latta, *op. cit.*, pp. 234–41.

[21] Smith, *op. cit.*, p. 166. The Rexroad formation, described and named by Smith, is now regarded as probably being late Pliocene. The Kingsdown formation embraces Illinoian and Sangamonian time. See C. W. Hibbard, "New Stratigraphic Names for Early Pleistocene Deposits in Southwestern Kansas," *American Journal of Science*, Vol. 256 (1958), pp. 54–59. The Ogallala formation is late Pliocene. See Frye and Leonard, *op. cit.*, p. 24.

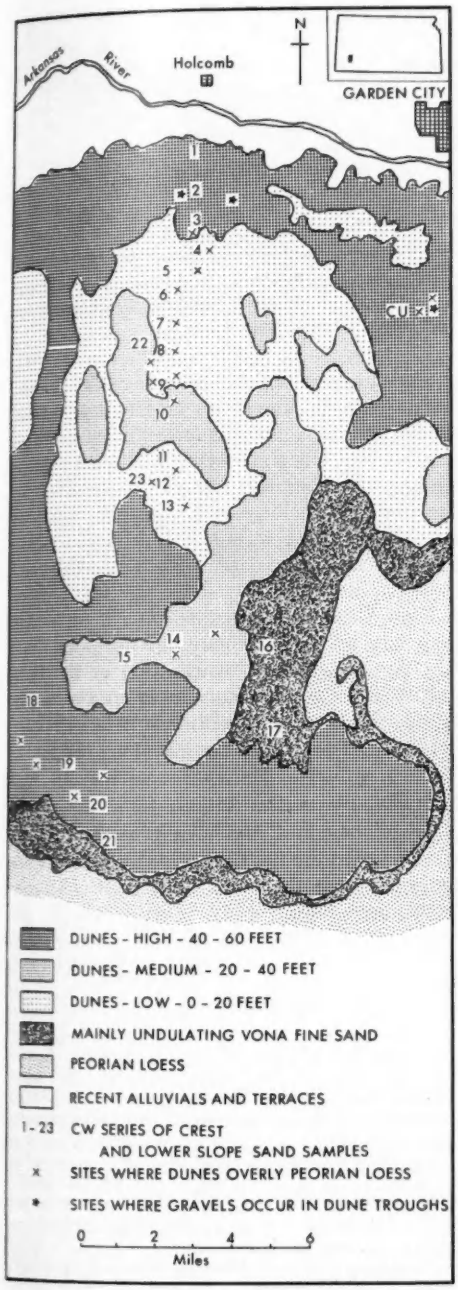
Arkansas River
Holcomb
N
GARDEN CITY
CU
DUNES - HIGH - 40 - 60 FEET
DUNES - MEDIUM - 20 - 40 FEET
DUNES - LOW - 0 - 20 FEET
MAINLY UNDULATING VONA FINE SAND
PEORIAN LOESS
RECENT ALLUVIALS AND TERRACES
1-23 CW SERIES OF CREST AND LOWER SLOPE SAND SAMPLES
SITES WHERE DUNES OVERLY PEORIAN LOESS
SITES WHERE GRAVELS OCCUR IN DUNE TROUGHS
0 2 4 6
Miles

FIG. 4. Garden City dune belt. There are numerous sites where dunes overlie Peorian loess.

This loess is dated as pre-Bradyan Wisconsinan, with a strong likelihood of being lower Peorian. The molluscan fauna on which this dating is based were collected from seven sites in the loess along the road running south from Holcomb through the heart of the dunes.[22]

The relationships of the dune sand to the loess and earlier deposits are given in Figure 5. This cross-section (based upon 15 power augerings to depths of 70 feet in a line due south of Holcomb) shows that the loess is almost continuous beneath the dunes from a point 2.3 miles south of the northern edge of the dunes, to the limit of the augering another 11 miles farther south. Aeolian sands, up to 20 feet in thickness, underlie much of the loess and these in turn overlie intensely weathered, reddish colored terrace sands and gravels of Kansan age.[23] At four of the augering sites (4, 7, 14 and 15) the Peorian loess lies directly on the Kansas terrace and the intermediate wind-blown sands are absent. At two of the augering sites (3 and 12), and at a hand-augered hole one mile west of power-auger hole 15, the loess is absent and either the modern dunes are directly superimposed on the Kansan terrace sands and gravel or they are mixed with pre-Peorian aeolian sands over the Kansan deposits.

The relative continuity of the loess below the present dunes would seem largely to preclude either the pre-Peorian wind-blown sands or the Kansan terrace sands as a major source for the surface dune sands. However, the earlier wind-blown sands at least must have formed a partial source in areas where thin loess could easily be removed by deflation. As already noted the loess is quite thin in a

[22] The fossil molluscs were identified by Dr. A. B. Leonard and Mr. Tong-yun Ho of the University of Kansas. The following species were noted: *Pupilla blandi* Morse, *Vallonia gracilicosta* Reinhardt, *Succinea avara* Say, *Pupilla muscorum* (Linne), *Vertigo milium* (Gould), *Hawaiia minuscula* (Binney), *Discus cronkhitei* (Newcomb), *Vallonia pulchella* (Muller), *Succinea grosvenori* Lea, *Lymnaea parva* Lea, and *Succinea* sp.

[23] The identification of the Kansan fauna obtained from three of the power auger sites was carried out by Mr. Tong-yun Ho of the University of Kansas. The species identified were: *Derocerus laeve* (Müller), *Discus cronkhitei* (Newcomb), *Lymnaea parva* Lea, *Gyraulus labiatus* Leonard, *Succinea grosvenori* Lea, *Vallonia gracilicosta* Reinhardt, *Valvata tricarinata* Say, *Physa anatina* Lea, *Vertigo gouldi* (Binney), *Promenetus umbilicatellus* (Cockerell), *Lymnaea bulminoides* Lea.

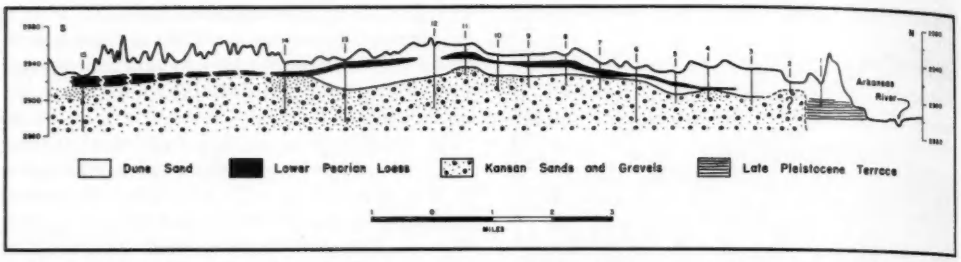

FIG. 5. Geologic cross-section of the dunes and underlying deposits south of Holcomb. The sites and depths of the 15 power augerings are also given. The question mark under site 2 indicates the uncertain age of the terrace at that point. The auger penetrated only 2 feet into the terrace gravels.

number of places, being barely 2 feet thick. Also, Peorian loess exposed in a two-acre gravel pit four miles south of Garden City (CU in Figure 4), showed remarkabe variations in thickness, pinching out several times and expanding to a thickness of four feet little more than 100 feet away. On the basis of this somewhat fragmentary evidence it clearly is not possible either to reject or to accept the pre-Peorian deposits as a major source for surface dune sand, though they must form a partial source.

In a recent study of the dunes west of Syracuse, Mettler found that early Wisconsinan (Peorian) loess overlay portions of the terrace, and in six borings he encountered loess over terrace deposits within a few hundred yards of the northern edge of the dunes and of the terrace.[24] In another study, Stramel, Lane, and Hodson put down numerous test holes in the dunes between Pierceville and Cimmaron, within 1 to 4 miles of the Arkansas River.[25] An inspection of the test hole samples in the sample library of the State Geological Survey of Kansas showed very fine sandy loess from 4 to 11 feet thick beneath the dune sands in 11 of 13 test holes (Fig. 6). In the two northern test holes in which loess was not definitely present, however, a fine dusty sand was noted beneath the dunes. This fine sand may be equivalent to the loess. As may be seen in Figure 6, loess extends at least within one mile of the present flood plain to the south of Charleston, and within one and three quarter miles south of Cimmaron. The small samples did not contain gastropods, but the topographic position of the loess, its color, depth, particle size, and apparent lack of weathering are closely akin to the Peorian loess of the Garden City and Syracuse areas.[26]

From this evidence in the Ingalls, Holcomb, and Syracuse areas it may be concluded that: (1) the widespread distribution of the loess argues for its continuity over much of the terrace deposits; (2) while the relatively narrow strip of loess-free terrace along the northern fringe of the Holcomb and Ingalls areas undoubtedly was a source for dune sands, it probably could not have provided enough sand to account for the broad band of dunes lying south of the loess-free strip;[27] (3) contributions of sand from the pre-Peorian deposits are probably also insufficient to account for the volume of sand mantling the loess deposit; (4) the extent of the loess beneath

[24] See D. E. Mettler, "Dune Sands of the Syracuse Area in Kansas," unpublished M.S. thesis, University of Kansas, 1955, pp. 60–67.

[25] G. J. Stramel, C. W. Lane, and W. G. Hodson, "Geology and Ground-Water Hydrology of the Ingalls Area, Kansas," *University of Kansas Publications*, State Geological Survey of Kansas, Bulletin 132 (1958), pp. 1–154.

[26] Stramel *et al.*, *op. cit.*, p. 25, consider that all the deposits under the dunes (including the loess) between Pierceville and Cimmaron "have been beveled by erosion and could have been the source of overlying dune sand." The presence of loess as much as 11 feet thick within the areas presumably subjected to as much as 60 feet of beveling clearly implies that the beveling must have preceded loess deposition, not followed it. It does not seem very likely that the dune sands were derived from the sands beneath the loess. The beveling may have taken place during the Sangamon interglacial period.

[27] Part of the terrace deposits consist of gravel. In areas where lenses of gravel were subjected to deflation, the gravels would retard further lowering of the removal bed and hence reduce the potential of the terrace as a sand-supply source.

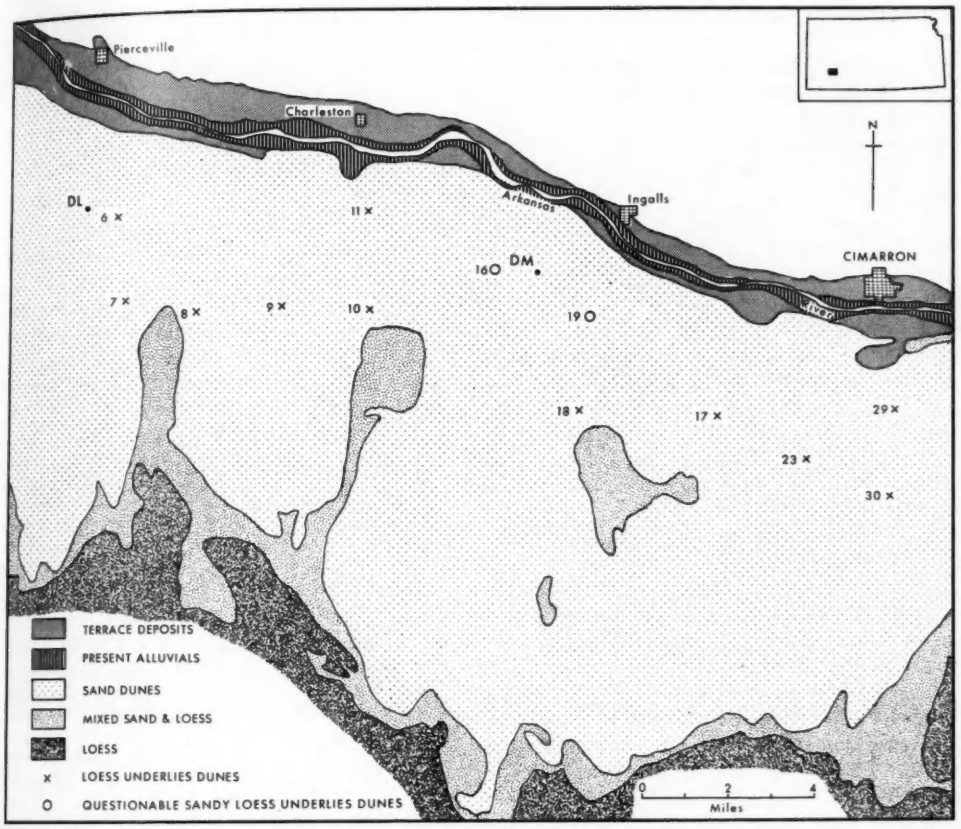

FIG. 6. Ingalls dune belt, showing the location of test holes in which loess directly underlies dunes.

the dunes strongly suggests that the major sand sources lay in the north of the dune belt. In other words, it would seem that the dunes were, in the first instance, built by winds dominantly from the north, rather than from the south.

The only other reasonable source of sand at the time of dune building would have been provided by the Wisconsinan alluvials of the Arkansas River. It is suggested here that the Wisconsinan alluvials did also provide sands for dune growth, along with the loess-free portions of the terrace and pre-Peorian aeolian sands. These three sources would have been competent to supply the volume of sand needed for the growth of the dune fields. It may be more than coincidence that the variations in the width of the Wisconsinan flood plain, as shown by the extent of the lowest terrace remnants, crudely parallel the variations in width of the dunes.

Although the present-day alluvials of the Arkansas along this section of its course are largely dune free, the absence of dunes is no indication that the Wisconsinan flood plain could not have acted as a sand source. In other parts of Kansas the present flood plains and the Wisconsinan terrace have small dune areas, even in the humid eastern part of the state.[28] Smith's rejection of the *present* river flood plain of the Arkansas as a source does not run counter to the above view.[29] The situation during the Wisconsinan need not have mirrored the present.

The conclusion earlier that sand was driven

[28] For example, in Saline, Clay, Ottawa, and Shawnee counties, to name a few.

[29] Smith, *op. cit.*, p. 166.

from the north was also reached by Smith who states that "the great extent of the dune belt on the south side of the Arkansas River, in contrast to the absence of any but a few small patches on the north side of the valley, itself points to development by winds from the north. The testimony of dune bedding agrees, for where low-angle backset bedding is to be seen, it commonly shows a northerly dip."[30] Smith argued further that "it is evident that dune building dates back to a time when wind movement was different from that of today, and it is suggested that the presence of a continental ice sheet during one or more of the Pleistocene glacial stages would have provided a ready cause for altered wind directions."[31]

Smith's argument for a Pleistocene (in this area, post-Lower Peorian) initiation of the surface dunes under the influence of northerly winds may reasonably be accepted. While the evidence is by no means clear-cut it is tentatively suggested that they first formed in late pre-Bradyan time, shortly after the deposition of Peorian loess. The arguments pro and con this suggestion are given below.

In a recent study of the Sandhills of Nebraska, Smith found evidence of three ages of sand-dune formation. The earliest of these he interpreted as having developed in the early Wisconsinan under strong northerly periglacial winds. The working of the Nebraska Sandhills during this time may have provided part of the Peorian loess of Kansas. In late Wisconsinan time a second set of dunes were developed in Nebraska in response to winds "more or less similar to those of today, but contrasting sharply with those of the first episode of dune building."[32] If there was an equally clear change of the wind regime after the Bradyan interglacial in western Kansas, then we might conclude that the dunes of the study area formed in late pre-Bradyan time. On the other hand, relatively little change from the present climatic regime may be needed to make northerly winds the dominant sand movers. It is conceivable that the late Wisconsinan could have been a time of more effective (if not stronger) northerly winds than today, without necessarily requiring a drastic change in wind direction from the present.

Soil development in thick loess buried by dunes south of Holcomb appears to be weaker than that noted by Thorp, Johnson, and Reed, and by Frye and Leonard, as being typical of the Bradyan soil in southern Nebraska and northern and west-central Kansas where the Brady soil is developed in Peorian loess overlain by Bignell loess.[33] This may indicate a short lapse of time between the deposition of the loess and the mantling of the loess in

[30] *Ibid.*, p. 168.

[31] *Ibid.*

[32] H. T. U. Smith, "Use of aerial photography for interpretation of dune history in Nebraska, U.S.A.," *IV Congrès de l' Association Internationale pour l' Etude du Quarternaire*, Rome (1953), pp. 1–7.

[33] J. Thorp, W. M. Johnson and E. C. Reed, "Some post-Pliocene buried soils of the central United States," *Journal of Soil Science*, Vol. 2, Part 1 (1951), pp. 1–19. Of the Brady buried soil, where developed in Peorian loess in southern Nebraska, north-central and western Kansas, Thorp, Johnson, and Reed state that "Some of it is a Chernozem-like silt loam without textural variation in the profile; and some of it has a mottled subsoil suggesting that it may be a preserved Wiesenboden or Humic-Gley soil."

Also see Frye and Leonard, *op. cit.*, pp. 133–34. The Brady buried soil in northwestern and west-central Kansas, again developed in Peorian loess overlain by Bignell loess, as described by Frye and Leonard, has a profile "[which] is moderately to poorly drained, and the depth of leaching ranges from about 1 to 3 feet. The A horizon is generally dark and caliche nodules one-half inch to 1 inch in diameter occur in the base of the B horizon. The B horizon is generally dark gray to gray brown and in some localities has clay accumulation and good structure whereas at other localities little textural contrast occurs between the A and B horizons. The profile of the Brady is generally deeper than the modern profile developed on the overlying Bignell loess, but this contrast may not be significant because at many of the Brady exposures this buried soil is judged to have developed under conditions of poorer drainage than did the modern soil at the same locality."

The intensity of soil profile development in the buried or partially buried loess south of Holcomb is quite variable, but the color tones of the loess are always strongly evident. The variations in profile are believed to be explicable largely in terms of the varying length of time the loess has been exposed in dune troughs, and hence has been open to weathering and soil formation, during progressive changes of dune location in the Wisconsinan and Recent. One of the profiles recorded is as follows:

S.E. ¼ sec. 13 T26S, R34W, Finney County, close to site CW 14 in Figure 4.

0–6	inches	Dune sand
6–63	inches	Pale brown fine sandy loam, massive; sandy Peorian loess as shown by the contained gastropods.

FIG. 7. Vegetation cover in lightly-grazed area six miles southwest of Kendall. Sand bluestem, sand sage, and soapweed are the dominants. The original cover before occupation probably was very similar to this relict area. Most of the dunes have a much denser cover of sand sage. Photo by Dr. F. W. Albertson.

turn by dunes, or it may result simply from the stripping of surface soils by deflation of the loess appreciably later, as dunes migrated back and forth across its surface. Since hand and power augering did not reveal any buried loess soils with significant profile development I would lean to accepting a short lapse of time between loess deposition and dune growth and would regard a late pre-Bradyan beginning for the dunes as the best guess at this time.

Some wind drifting took place before Peorian loess deposition as shown by the characteristic narrow dune-type grading of the sand beneath the loess. These sands are as well sorted as the surface dune samples and could easily be interchanged with the latter (see, for instance, the grading of sample CU 16 in Fig. 17, taken from sand beneath the loess). It is not clear when this earlier phase of sand movement occurred, though it is not improbable that it also could be very early Wisconsinan and immediately preceded the loess deposition.

Recent and Probable Pleistocene Vegetation on the Dunes[34]

The final questions on the genesis of the dunes concern the role of vegetation during their development. To answer these questions it is necessary first to consider the existing

63–87	inches	Pale yellowish brown massive very fine sandy loam in very fine sandy loess; fossils present as above.
87–111	inches	Light grey brown loess, texturally a clay loam, much finer than the loess above.

[34] I am indebted to Dr. F. W. Albertson of Fort Hays State College in Kansas for supplying unpublished information on the vegetation of the area (south of Lakin) between Garden City and Syracuse. Dr. R. L. McGregor of the Botany Department, University of Kansas, critically read the section on vegetation.

cover and then to speculate on the likely cover throughout the Wisconsinan period.

At the present time the dunes are essentially fixed by a grass and low shrub vegetation (Fig. 7), although there are some areas where moving sand is to be seen. Grazing since the first occupation of the area in the mid-1880's has appreciably modified the flora and altered the relative dominance of the major components of the sward, but it is nonetheless possible to reconstruct the essential character of the vegetation at the time of first occupance, as indicated by lightly grazed areas of the present day.[35]

For the dunes as a whole the sand bluestem (*Andropogon hallii*) is often the most important single species in little-used areas, and although there is some doubt as to the relative status of the sand sage (*Artemisia filifolia*) most of the evidence indicates that it was much less prominent in the original community than now.[36] Other grasses of importance are switch grass (*Panicum virgatum*), little bluestem (*Adropogon scoparius*), side-oats grama (*Bouteloua curtipendula*), hairy grama (*B. hirsuta*), sand dropseed (*Sporobolus cryptandrus*) and sand paspalum (*Paspalum stranieum*). The distinctive small soapweed (*Yucca glauca*) is everywhere present as a noticeable member of the community.

The most important sand binders in blowouts are blowout grass (*Refieldia flexuosa*) and the sand reed grass (*Calamovilfa longifolia*), both characterized by extensive creeping root stocks. Of these, blowout grass is the most aggressive, being the major sand binder of a sizable part of the dunes everywhere in the Great Plains from the Nebraska Sandhills into Oklahoma. Additional species which seem to have sand-holding abilities are the sand milkweed (*Asclepius arenaria*), *Panicum virgatum*, and *Physalis lanceolata pumila*, the deep slender roots of which apparently enable them to survive moving sands. Many other species are present as well but those given above include all the usual dominants and account for much of the ground cover.

In Recent time the dunes undoubtedly have been subject to constant modification by blowouts, as shown by the blurred outlines of some blowout scars and the freshness of others. Not the least important evidence to this effect is the dominance of dune troughs aligned from south-southwest to north-northeast. Unless the dominant winds of early Wisconsinan were exactly opposite to those of the present, the presumed pre-Bradyan alignment of the dunes has apparently all been destroyed. In addition to blowouts, free dune migration must have taken place prior to settlement, through the amalgamation of blowouts after extended droughts, fires, and the like, and by recurrent episodes of greater aridity, such as those of the 1930's, which could lead to some loss of soil stability and produce intermittent free-dune migration across the dune field. Early settlers in western Kansas make reference to free dunes in their reports of the dune areas.[37] Thus, there are good grounds for believing that modification of the dunes during Recent time has been by free-dune movement as well as by blowouts.

Since the best evidence available indicates that the climate during the mid and late Wisconsinan was broadly akin to that of today, and since it may reasonably be inferred that much the same vegetation stabil-

[35] No published detailed ecological work is available on the dunes. In addition to the unpublished data provided by Dr. Albertson, the following sources were used: A. A. Hitchcock, "Ecological Plant Geography of Kansas," *Transactions of the Academy of Science of St. Louis*, Vol. VII (1898), pp. 69–70; J. E. Weaver and F. W. Albertson, *Grasslands of the Great Plains* (Lincoln: Johnsen Publishing Co., 1956), pp. 164–92 (on the Sandhills of Nebraska), and pp. 261–66 (on the sand dunes of Oklahoma; vegetationally the latter are very similar to the Garden City dunes); J. H. Doell, "The Flora of the Sand Hills of Central Kansas," *The University of Kansas Science Bulletin*, Vol. XXV, No. 3 (1938), pp. 113–47; and J. W. Harshberger, *Phytogeographic Survey of North America* (New York: G. E. Stechert and Co., 1911), pp. 625, 531–33.

[36] Hitchcock, *op. cit.*, p. 69, for example, noted in 1898 that "*Artemisia* forms a thick crown and helps materially in retarding the shifting sand." Since Hitchcock was writing less than 15 years after the first use of the dunes for grazing, and presumably the dunes were only slightly modified from their pristine condition, *Artemisia* may well have been very prominent in the community. On the other hand, Weaver and Albertson, *op. cit.*, p. 262, consider that in nearby dune areas in Oklahoma "sand sage has increased enormously" at the expense of the grasses.

[37] For example, Hitchcock, *op. cit.*, p. 69, commented in 1898: "At Hartland there are several miles of shifting dunes known as the bald hills. . . . The inhabitants of the region informed me that the bald hills are less extensive than formerly."

ized the dunes at that time as now, it seems reasonable to believe that intermittent free dune migration and blowout extension have characterized this dune area almost from its beginning.[38]

Climatic conditions were probably not too dissimilar during the early Wisconsinan and the same argument may apply, though with less force, for pre-Bradyan time. On the basis of the molluscan fauna of the early Wisconsinan, Frye and Leonard argue that "a reasonable amount of rainfall, at least more than present average amounts, and a floral cover somewhat denser than that on the Great Plains today may be inferred from the molluscan faunas in pre-Bradyan sediments. The climate may also have been somewhat cooler than that which characterizes the Great Plains today."[39]

GRADING OF THE DUNE SANDS

Since near-northerly and near-southerly winds have been, and still are, dominant in dune building, the changes in the grading of the sands brought about by dune development may most expeditiously be studied by using samples collected along north-south transects through the dunes. As far as was feasible, samples were taken at approximately half-mile intervals along three north-south roads traversing the dunes. One of these transects runs south from Holcomb (Fig. 4), another runs south from Syracuse (Fig. 14), and the third is south of Kendall (Fig. 14). Some areas depart from a simple linear sampling, especially far south of Garden City, where the only roads are oil-well service roads which wander through the dunes. In all three transects some samples for separate screening were taken from dune crests, lower east or west slopes, and troughs. South of Holcomb in particular, a series of samples from immediately adjoining crests and lower slopes (the latter lying directly east or west of the crest sites) were obtained for comparison. All the samples were short channel samples six inches thick, collected by spade from the subsurface, below the zone of significant accumulation of organic matter in the present-day soils. Since humus contents in the 18- to 24-inch sampling depth rarely exceed 0.5 percent, the effect of organic matter may be ignored as the error introduced lies within the experimental error of the analytical methods used to determine the grading.

TABLE 2. PERCENTAGE OF FINE PARTICLES IN THE CW SERIES OF DUNE SANDS

Sample number	Crests (CW)			Lower Slopes (CWS)		
	Percentage of—			Percentage of—		
	Dust[1]	Silt[2]	Clay[3]	Dust[1]	Silt[2]	Clay[3]
1	2	1	4	3	1	4
2	0	1	3	5	1	7
3	0	1	4	9	2	7
4	0	1	5	6	1	8
5	0	1	6	9	4	7
6	0	1	3	5	2	7
7	0	1	5	8	3	7
8	0	1	4	10	4	12
9	0	0	5	15	5	15
10	0	1	3	8	3	6
11	0	1	3	10	3	7
12	0	1	4	4	1	4
13	0	2	4	not available		
14	2	1	6	1	1	5
15	2	1	8	not available		
16	1	1	4	3	5	11
17	2	1	4	not available		
18	1	1	4	not available		
19	1	1	4	2	1	11
20	1	1	4	4	2	7
21	3	3	13	not available		
Average[4]	0.6	1.0	4.3	6.4	2.3	7.9

[1] In the size range 0.05 to 0.02 mm.
[2] Of 0.02 to 0.002 mm.
[3] Smaller than 0.002 mm.
[4] Excluding sample No. 21.

Dry sieving and hydrometer techniques were used to obtain the gradings of the sands. The oven-dry equivalent of 100 grams was taken, dispersed with sodium hydroxide and Calgon, and the percentage of the sample smaller than 0.05, 0.02, and 0.002 mm. was obtained with a Bouyoucos hydrometer in a 67°F constant-temperature bath. These results are given in Tables 2, 3, and 4. After decantation of particles smaller than 0.045 mm., the residue was oven-dried, reduced to 50 grams, and then sieved for 30 minutes in a nest of previously unused Tyler sieves on a Ro-Tap sieving machine. The standard time of 30 minutes and the standard weight of 50 grams were selected as most satisfactory for the present samples, after testing for reproducibility of results with a range of

[38] See Frye and Leonard, *op. cit.*, p. 180, for a commentary on Bradyan and post-Bradyan climates. Weaver and Albertson, *op. cit.*, p. 11, consider that the vegetation of the Great Plains during the Wisconsinan was closely akin to that of today.
[39] Frye and Leonard, *op. cit.*, p. 177.

TABLE 3. PERCENTAGE OF FINE PARTICLES IN THE EA AND ED SERIES OF DUNE SANDS

Sample number	EA Series			ED Series		
	Percentage of—			Percentage of—		
	Dust[1]	Silt[2]	Clay[3]	Dust[1]	Silt[2]	Clay[3]
1	1	0	5	0	1	5
2	1	0	4	0	0	4
3	0	1	3	0	1	3
4	0	1	4	0	1	4
5	2	3	5	0	0	5
6	0	1	5	0	2	4
7	0	0	5			
8	3	0	7			
9	18	11	19			
10	2	1	8			

[1] In the size range 0.05 to 0.02 mm.
[2] Of 0.02 to 0.002 mm.
[3] Smaller than 0.002 mm.

TABLE 4. PERCENTAGE OF FINE PARTICLES IN THE BARCHAN, DM, DL, CU16, CW22, AND CW23 SERIES OF DUNE SAMPLES

Sample number	Percentage of—			Sample number	Percentage of—		
	Dust[1]	Silt[2]	Clay[3]		Dust[1]	Silt[2]	Clay[3]
Barchan series[4]							
1	1.1	0.6	5.0	DMa	1	3	8
2	0.4	0.9	5.1	DMb	1	3	8
3	0.1	1.2	5.4	DL8	1	3	11
4	0.3	0.8	5.0	CU16	0	1	5
5	0.5	0.1	4.2	CW22a	2	4	9
6	0.1	0.0	5.0	CW22b	2	3	12
7	0.2	0.0	3.6	CW22c	2	3	12
8	0.5	0.9	4.4	CW22d	2	3	12
9	0.1	0.0	4.0	CW23a	3	2	7
10	0.4	0.3	4.3	CW23b	8	6	13
11	0.7	0.0	3.1				

[1] In the size range 0.05 to 0.02 mm.
[2] Of 0.02 to 0.002 mm.
[3] Smaller than 0.002 mm.
[4] Barchan series determined with pipet.

sample weights and shaking times. The full range of sieves of the Tyler Fine Series was used (21 sieves) between the limiting diameters of 1.68 to 0.053 mm.[40] Sieve residues above 1 gram were weighed to 0.01 gram, those below, to 0.001 gram. To make all sievings strictly comparable for discussion, the residue on each sieve was converted to a percentage of all particles larger than 0.053 mm. These percentages were then plotted graphically to enable ready comparisons of grain-size gradings. Some 74 representative samples were selected and plotted on a series of graphs.

Bagnold's method of plotting the results was used. In this method the logarithm of the percentage weight of sand per unit of the log-diameter scale is plotted as ordinate against an abscissa of the log grain diameter. Bagnold found that in naturally wind-blown sands "outside a definite central zone the grades to right and left of the peak [diameter] fall off each at its own constant rate."[41] To those wind-blown sands whose grading conformed to this simple arrangement of two straight lines inclined upwards, meeting at an apex the top of which was replaced by a small arc, Bagnold applied the term "regular sands," whether the arrangement was symmetrical about the peak or not.[42] Various other methods of plotting the results were tested, including cumulative curves on probability paper using the phi scale, Harris' modified Gaussian curves, and a number of simpler arithmetic and semi-logarithmic cumulative frequency and percentage frequency diagrams.[43] No one of these alternative methods appears to be as satisfactory as Bagnold's in revealing the logarithmic functions of wind-blown sands and in giving the peak diameters in simple millimeter sizes, as well as showing all grain-size grades present with a sensitivity equal to that obtained by plotting on logarithmic probability paper.

Rate of Adjustment of Sand Gradings on Wind Movement

The logarithmic law for grain-size sorting which holds for wind-blown sands in adjustment to their environment of deposition, as shown by Bagnold, Simonett, Chepil, and

[40] The sieve meshes used were as follows (in millimeters): 1.68, 1.41, 1.19, 1.00, .84, .71, .59, .50, .42, .35, .297, .250, .210, .177, .149, .125, .105, .088, .074, .062, .053.

[41] Bagnold, *The Physics of Blown Sand . . . , op. cit.*, p. 114.

[42] *Ibid.*, p. 118.

[43] For a full explanation of the phi scale, see W. C. Krumbein, "Size Frequency Distribution of Sediments," *Journal of Sedimentary Petrology*, Vol. 4 (1934), pp. 65–77, and also D. L. Inman, "Measures for Describing the Size Distribution of Sediments," *ibid.*, Vol. 22 (1952), pp. 125–45. The modified Gaussian curve is described by S. A. Harris, "Probability Curves and the Recognition of Adjustment to Depositional Environment," *ibid.*, Vol. 28 (1958), pp. 151–63.

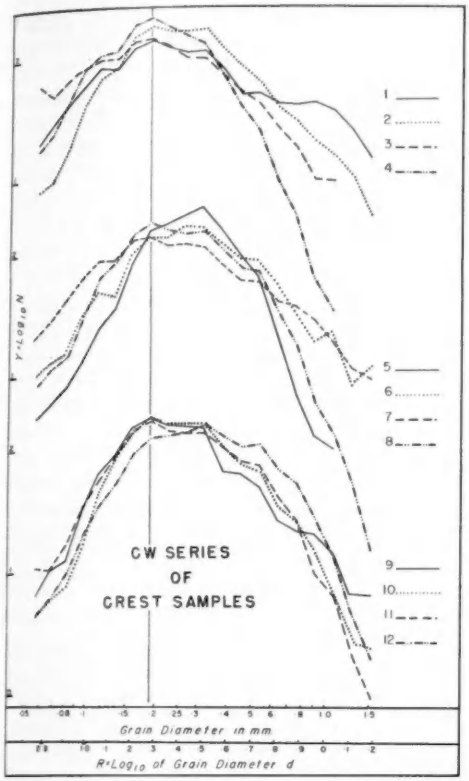

FIG. 8. Grain-size gradings of the northern group of CW series of crest samples. Note the wide and not very regular grading.

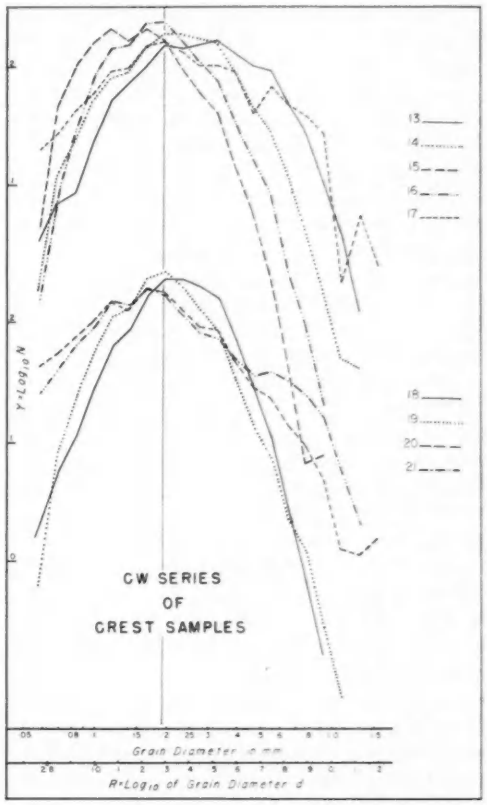

FIG. 9. Grain-size gradings of the southern group of CW series of crest samples. Compare the narrow, steep grading of samples 14, 15, 16, 18, and 19 (most representative of the southern sands) with the wider and less regular gradings of the northern sands. Samples 17, 20, and 21, taken from broad dunes, lie on the edge of the dune belt and may be subject to contamination. Sample 13 is a northern group sample included for comparison.

Harris, is not confined to aeolian deposits.[44] In a recent study in Egypt, Harris found that coarse-textured deltaic, fluviatile and marine deposits also followed a logarithmic probability function when such deposits were in adjustment to their depositional environment.[45] As might be expected, however, the functions for these different deposits differ from one another as well as from wind-blown sediments, presumably reflecting the different mechanisms involved in transportation and deposition. Thus, when sands which have been deposited under one set of conditions are transported by a different method, the gradings will change so as to bring the sands into logarithmic equilibrium with the new sorting process. Since the sands which formed the source for the dunes between Cimmaron and Syracuse were alluvial deposits, we would expect to find some changes in grading from north to south as the sands were driven away from their source area, if these vegetated dunes follow the same basic laws as free dunes.

[44] See Bagnold, *The Physics of Blown Sand . . .*, *op. cit.*, p. 114; Simonett, *op. cit.*, p. 75; W. S. Chepil, "Dynamics of Wind Erosion. VI. Sorting of Soil Material by the Wind," *Soil Science*, Vol. 61 (1946), pp. 331–40, and S. A. Harris, "Differentiation of Various Egyptian Aeolian Micro-Environments by Mechanical Composition," *Journal of Sedimentary Petrology*, Vol. 28 (1958), pp. 164–74.

[45] Harris, "Probability Curves . . . ," *op. cit.*, p. 154.

These changes may be explored by first considering the series of crest samples taken to the south of Holcomb, the locations of which are given in Figure 4. These samples, plotted as the CW series in Figures 8, 9, and 10, fall into two broad groups on the basis of the gradings: a northern group comprising samples CW 1 through 13 and a southern group of samples CW 14 through 21. The southern group is rather more regular than the northern group and has steeper slopes on both coarse and fine sides of the peak diameter, on the coarse side reaching the apparently limiting slope coefficient of 9, as found both experimentally and in the field by Bagnold.[46] The mean gradings of the two groups given in Figure 10 clearly show the marked steepening on the coarse side, and the over-all narrowing of the grading of the southern sands compared to the northern group. They also show a tendency to a more definite and sharper peak in the southern sands, as opposed to the broad diffuse peak in the northern sands.[47] Since the tendency is to an improvement in gradings from north to south, the earlier conclusion that the sands were driven from north to south seems to be reinforced by these observations.[48] It also would appear that the present dominance of southerly winds has had relatively little influence in changing the gradings of the sands.

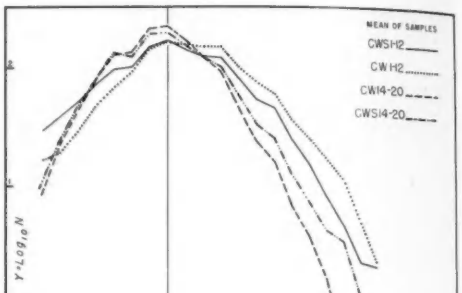

FIG. 10. Mean grain-size gradings of the northern and southern groups of crest and lower slope samples of the CW series. The crest and lower slope samples of the southern sands are narrower and more regular in grading than the northern sands.

The approach to regularity poses two related questions: (1) Why is there such an abrupt change from the northern to the southern group in regularity of grading, rather than a gradual change? (2) Why are the gradings in the north so irregular, in view of both Bagnold's and Chepil's conclusions that very short distances (in Chepil's case one-fourth to one-half mile) are needed to effect regularity?[49] As noted in my earlier paper on the Castlereagh sand dunes, both Bagnold's wind tunnel experiments and Chepil's analyses of small dunes resulting from drift from eroding wheat fields involved small volumes of sand in movement. The Castlereagh dunes required between two to three miles of transport to achieve regularity, and this led me to suggest in the Castlereagh study that the amount of sand in movement would greatly influence the attainment of regularity, "the speed of sorting depending on the continuity of supply of irregular sand from up wind. With large volumes of sand available for movement, fresh sand (with grading irregularities) would continually . . . [move] over areas in which . . . [these irregularities re-

[46] Bagnold, *The Physics of Blown Sand . . . , op. cit.*, pp. 115–16, expressed the steepness of the slope of the arms of his grading diagram as a coefficient obtained by "dividing the vertical interval between any two points on the straight arms [of the grading diagram] by the horizontal interval between them, using in each case the logarithm scale for measurement."

[47] Many of the samples in the CW series and in the other sievings considered later show a very pronounced kink in the grading curve on the fine side of the peak diameter. This kink, which occurs with sands resting on sieve 100 (plotted as 0.16 mm.), results from the use of a sieve with a too-small mesh aperture. When it was realized that this sieve was faulty it was replaced by another with the proper opening. In all those cases where this kink in grading is present, the faulty sieve is responsible. Bagnold, *ibid.*, p. 124, describes a method whereby this kink might be removed, but it was not employed in the present case.

[48] Samples 17, 20, and 21 are not very regular. However, these samples were taken on the crests of broad dunes close to the margins of the dune belt and may be contaminated by coarser sands now being scooped from the troughs under the action of southerly winds.

[49] *Ibid.*, p. 143, and Chepil, *op. cit.*, p. 337.

mained] as residuals from earlier movement emphasizing the irregularities and in effect shifting the removal bed down wind. It is possible with certain initial gradings and with large masses of sand for transport that the attainment of regularity may be even longer delayed than at Castlereagh."[50] It is suggested that the above argument partly answers the two questions. The dunes in the northern portion of the area undoubtedly have moved little from their source; hence achievement of regularity there would largely be by upward growth, while for those drifted south, the break in grading between samples CW 13 and CW 14 may perhaps be a response to "the effective shift of the removal bed down wind" only as far south as sample CW 13.

In addition to distance of movement, the height of crests above nearby troughs may influence the gradings. Quite the most regular and narrowest gradings are seen in samples CW 18 and CW 19, taken from the crests of two of the highest dunes in the area, rising almost 60 feet above their adjoining troughs. Conversely, the widest and poorest gradings are in general associated with the northern samples CW 4 to CW 13 (Figure 4), collected in the area of low dunes less than 20 feet high. A similar relationship was found by both Alimen and Harris in certain Algerian and Egyptian sands where the finest sands and the narrowest and most perfect gradings were noted on the highest dunes.[51] While the reasons for this relationship between dune height and grading are not fully known, Harris observes, for a dune climbing a scarp in Egypt:

> Clearly, in spite of the normal tendency for increase in wind velocity with height, sorting into zones parallel with the contours occurs, the coarser grades accumulating at the base of the scarp. This might possibly be caused by shearing sorting noted to occur on agitated inclined planes (Bagnold, 1941, p. 239) or it might be caused by the interaction of gravity slope and wind direction. In the latter case it is envisaged that the combined effects of gravity and slope might impart, on the average, a partial downhill motion to a grain knocked into the air by collision during saltation, since the angle of incidence equals the angle of reflection. The force of the airstream would tend to modify this until it was the same as that of the wind or until it landed, whichever occurred first. The greater the mass of the grain the longer it would take to be fully modified in its direction of travel for a given wind strength, owing to its greater mass and momentum relative to the increase in wind resistance. Thus a wind occurs tending to rise upslope while the larger grains continue to remain downslope. . . . More observations and possibly some experimental work are required before this problem can finally be solved.[52]

A similar explanation for the differentiation of gradings with height on a west Texas dune some 30 feet high was given in 1939 by Sidwell and Tanner.[53] Gervais also used a comparable argument to explain the differentiation of gradings with height on a very high (114 meters) maritime dune (dune du Pyla) in Gascony.[54] There thus appears to be strong evidence to support the view that dune height plays a significant role in influencing gradings in a wide variety of environments.

A third factor which may have a role in affecting gradings is the presence of vegetation during dune growth, particularly on the smaller dunes. At first sight it would appear that small dunes which suffer constant alteration by blowouts would not be likely to experience continued winnowing and sorting on the crests, or at least not to the degree typical of unvegetated dunes. Indeed, since blowouts often produce wholesale dismemberment of dunes it would seem probable that the sands in small vegetated dunes would be so thoroughly mixed as to give little opportunity for differentiation of gradings in response to elevation. Certainly the mechanism of blowout formation is such that in the late stages of a blowout the sand source would progressively become lower and presumably the wind would tap sands of wide and not very perfect grading. If this argument is correct it would follow that in low dunes there would be little differentiation between crest and lower slope gradings. This suggestion is considered in more detail below.

Since many of the low dunes are broad and have rather gentle slopes it is also probable

[50] Simonett, *op. cit.*, pp. 74–76.

[51] See Mlle. Alimen's comments appended to the paper by Bellair, *op. cit.*, p. 118. Also see Harris, "Differentiation of Various Egyptian Aeolian Micro-Environments . . . ," *op. cit.*, p. 172.

[52] *Ibid.*, p. 172.

[53] See R. Sidwell and W. F. Tanner, "Sand Grain Patterns of West Texas Dunes," *American Journal of Science*, Vol. 239 (1939), pp. 181–87.

[54] See D. Gervais, "Étude Morphoscopique de Divers Sables, *Annales de Centre D'Études et de Documentation Paléontologiques*, No. 5 (1954), pp. 1–64.

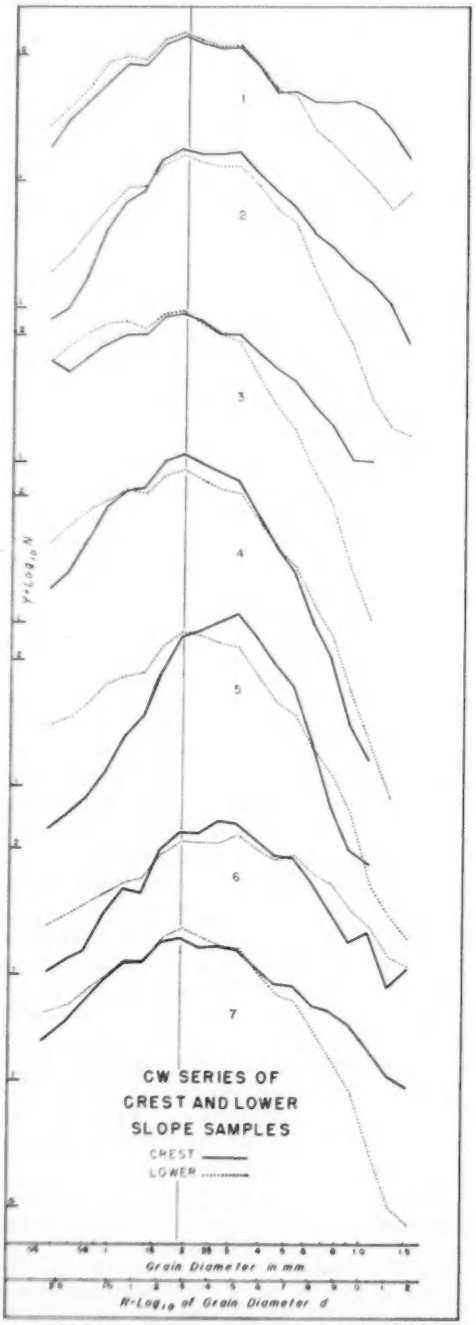

FIG. 11. Grain-size gradings of the CW series of crest and lower slope samples (1 to 7). There is a tendency for the slope samples to be steeper than the crest samples on the coarse side (unusual) and gentler on the fine side of the grading.

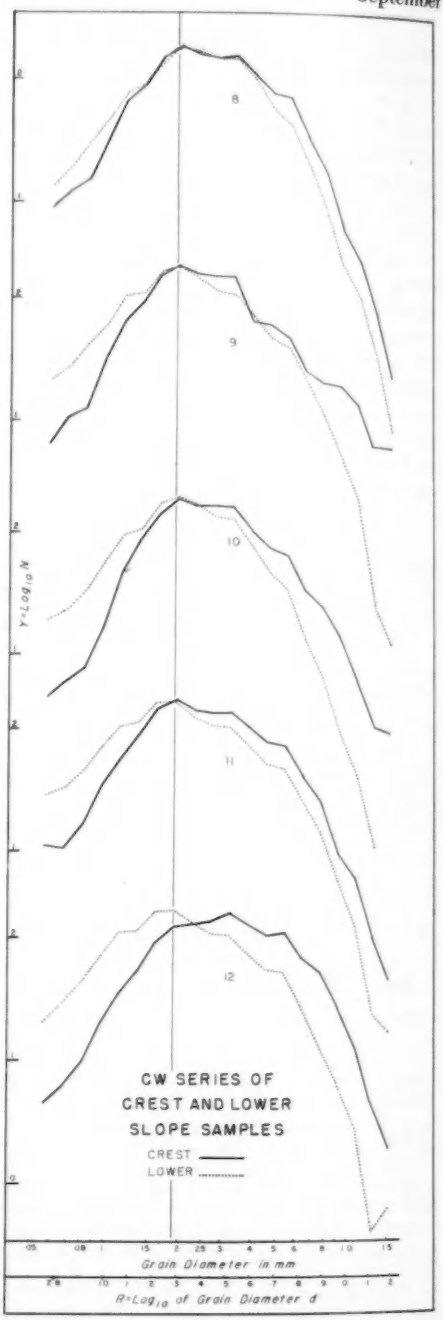

FIG. 12. Grain-size gradings of samples 8 to 12 of the CW series of crest and lower slope samples. The slope samples tend to be steeper on the coarse side (unusual) and gentler on the fine side of the grading than the crest samples.

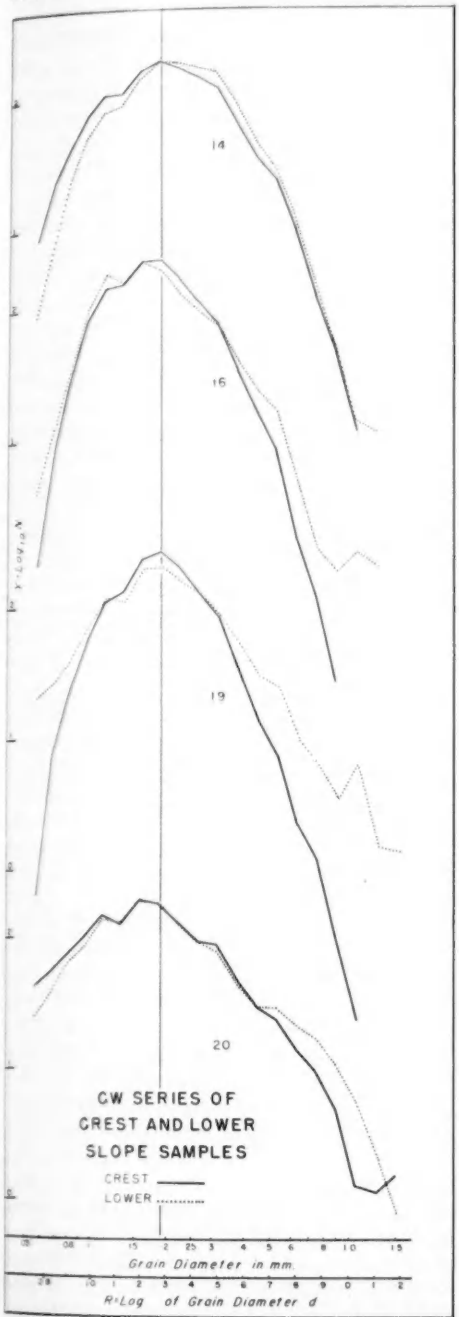

FIG. 13. Grain-size gradings of samples 14, 16, 19, and 20 of the CW series of crest and lower slope samples. All but sample 20 show steeper grading on the coarse side of the peak diameter in the crest than in the lower slope samples.

that gravity slope sorting as discussed by Harris operates to only a very limited degree in such dunes. The wide gradings on the crests of the low dunes south of Holcomb is at least compatible with this suggestion. However, since no precise data are available on the relationship between slope and sorting it is not possible to be more definite at the present time.

Whatever the reason, or reasons, for the differences in grading between the northern and the southern groups of sands in the CW crest series to the south of Holcomb, three general conclusions may be drawn from the preceding discussion. First, the gradings appear to conform in a general way with gradings on unvegetated dunes. Second, a vegetation cover coupled with blowout phenomena may dampen the sorting process. Finally, the speculative nature of much of the discussion clearly underlines the need for more detailed, quantitative studies.

Relationships between Crest and Lower Slope Gradings

A comparison between the crest and slope gradings of the CW series shows several points worthy of comment (Figs. 10, 11, 12, and 13). First, there tends to be relatively little difference between the peak diameters of crest and slope samples, although it is possible that a weak trend to slightly coarser crest peaks is present. As measured by the sieve with the maximum load, some twelve samples had identical peaks in crest and slope, another three had coarser crests than slopes, and one was finer on the crest than on the slope. Bagnold determined the peak diameter by projecting the coarse and fine arms of the grading curves to an intersection, but there are too many kinks in the gradings to make this a suitable method for the CW series. Given the opportunity to use this projection method, it is possible that greater (or lesser) differences between the peak diameters in crests and slopes would be noted than with the method used here. The number of sieves used also becomes important in making distinctions of this kind. Most geologists use from 10 to 13 sieves within the grain-size span of 2.0 to 0.5 mm., instead of the 21 used in the present study. Since it follows that the finer the sieve separation the more valid any distinctions which may be drawn, the conclu-

sion that there is little difference in peak diameter between the crests and slopes of the CW series rests on a more secure foundation than would normally be the case.

The relationships between the peak diameters of crest and slope samples in other vegetated dunes can only be described as confusing. For instance, Lewis found that longitudinal dunes in the Kalahari Desert in some cases showed little or no difference in peak diameters of the crests and lower slopes while in others the crests were coarser than the slopes.[55] Longitudinal dunes in the Simpson Desert of Central Australia, studied by Carroll and by Crocker invariably had coarser grading maxima on the crests than on the lower slopes and troughs.[56] I found this relationship reversed in the Castlereagh dunes west of Sydney (Australia).[57] These conflicting results may in part be related to the extreme fineness of the Simpson Desert sands. As Crocker points out the Simpson Desert sands are all very close to those diameters (0.15 to 0.08 mm.) which Bagnold showed experimentally are the easiest of all to move by the wind.[58] Even if true this explanation by no means accounts for all the variations noted above. Some of the Kalahari Desert samples, and some of the CW samples for that matter, have coarser crest than slope sands and both crests and slopes are themselves coarser than the Simpson Desert sands. A great deal more will need to be known about gradings on other vegetated dunes and of the mechanisms of the sorting of sands with differing peak diameters before any secure generalizations may be made on this problem.

A rather perplexing feature of the CW crest and slope samples is the nature of the coarse side grading. As may be seen in Figures 10, 11, 12, and 13, in the northern group of samples—CW 1-12 (crests) and CWS 1-12 (slopes)—all except samples 4, 5, and 6 have steeper and, if anything, rather more regular grading on the coarse side in the lower sites than in the adjoining crest sites. The southern group composed of samples CW and CWS 14, 15, 16, 19, and 20 reverse this relationship, showing steeper and more regular coarse-side gradings in the crest samples than in those from the slopes. The relationship in the southern group is essentially that reported in the literature on logitudinal and sif dunes elsewhere.[59] As far as could be determined, however, in no other dunes discussed in previous work are to be found coarse-side gradings comparable to those of the CW northern group (that is, in which the slope sands are steeper and more regular on the coarse side than the crest sands). It is possible that this unusual relationship may be connected with blowout formation in some way but the mechanism is obscure. Since regularity and steepness of coarse-side grading normally is a function of the amount of sand movement—the more movement the more regular and the steeper the grading—one is led to the curious conclusion that the slopes may actually be more effectively winnowed than the crests in the northern group of samples. It may perhaps be easier for the lower slopes to shed surplus coarse grades into the adjoining troughs than for the broad, gently sloping crests to eliminate excess coarse sands.

On the fine side of the peak diameter, the gradings of the crest sites are, with the exception only of samples 14 and 20, steeper than the lower slope gradings (Figs. 11, 12, and 13). Also, as may be seen in Table 2, there is a significantly greater amount of dust (0.05 to 0.02 mm.) and clay size particles (smaller than 0.002 mm.), especially the former, in the slope samples compared with the crest samples. The concentration of the finer grades, including dust, in the lower slope sites is a well-known phenomenon in other areas, being found in dunes of the Simpson and Kalahari deserts, and the Castlereagh dunes.[60] The reasons for the concentration of the fine grades in the lower slope sites of the above areas were discussed at length in the Castlereagh study, and it was concluded that particles smaller than 0.15 mm. would be selectively winnowed from the crest areas and deposited on the lower slopes and in the troughs because wind velocities are

[55] See A. D. Lewis, "Sand Dunes of the Kalahari," *South African Geographical Journal*, Vol. 19 (1936), pp. 22–34.

[56] See Carroll, *op. cit.*, p. 54; Crocker, *op. cit.*, p. 240.

[57] Simonett, *op. cit.*, p. 76.

[58] Bagnold, *The Physics of Blown Sand . . . , op. cit.*, p. 90.

[59] *Ibid.*, p. 228.

[60] Simonett, *op. cit.*, p. 76.

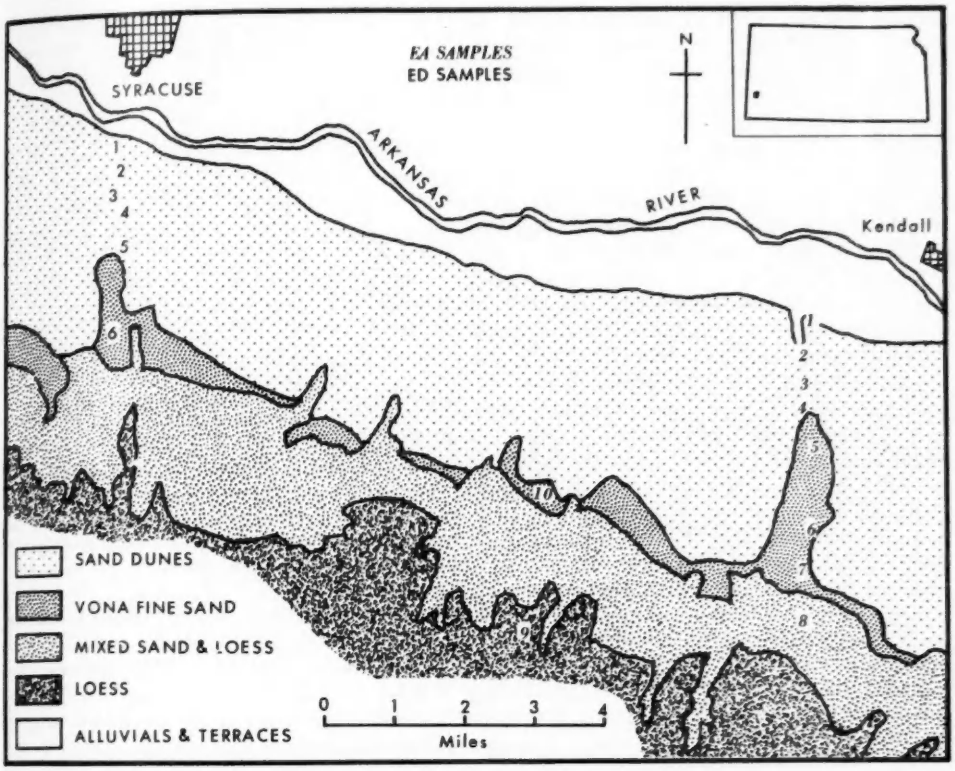

FIG. 14. Syracuse dune belt, giving the locations of the EA and ED series of samples.

necessarily lower at the base of the dune than at the crest.[61] As both Bagnold and Chepil have shown, very fine sand and coarse dust particles are the most easy of all grades to bring into and maintain in saltation and suspension.[62] In the western Kansas dunes, these fine grades, brought into movement by relatively gentle winds (above 10 mph) on the crests, would be directed outwards from the crest and would be easily trapped in the quieter, protected air-pools of the blowout basins.

It was suggested earlier, before the crest and lower slope samples of the CW series were compared, that constant modification by blowouts may so thoroughly mix the sands of small dunes as to make for little difference between crest and slope grading. Superficially, the fact that the same peak diameters are found on crest and slope of almost all the CW samples would seem to support this view. However, since there are significant differences in the grading of the crest

[61] *Ibid.*, p. 76.

[62] See W. S. Chepil, "Dynamics of Wind Erosion. II. Initiation of Soil Movement." *Soil Science*, Vol. 60 (1945), p. 404. The terms "suspension," "saltation," and "creep" used to describe the mode of transportation of sand grains may be defined as follows:

Suspension—The maintenance of very small grains in a bouyant state in the wind. The terminal velocity of fall of these particles is less than the velocity of upward eddy currents within the average surface wind.

Saltation—the bounding motion described by sand particles being driven by the wind. Grains move forward by a series of leaps, rising on the average rather less than 2 meters above the ground. First used by G. K. Gilbert in 1914 to describe the motion of sand grains in water, this term was adopted by R. A. Bagnold for the motion of sand in air.

Creep—the slow forward movement of large grains driven along the surface of the ground by impact from the particles moved by saltation.

The usage of all these terms follows that of Bagnold, *The Physics of Blown Sand . . . , op. cit.*, p. 37.

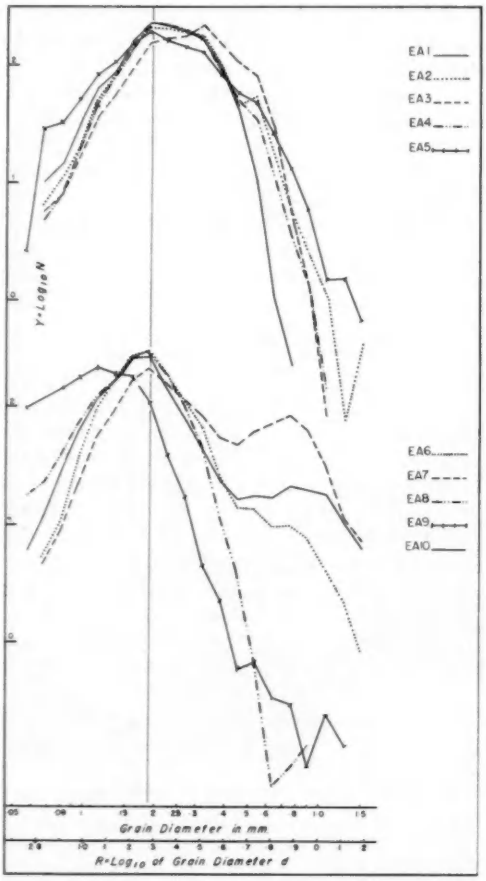

FIG. 15. Grain-size gradings of the EA series of samples. Unimodal gradings are characteristic of the crests of the higher dunes. Bimodal gradings are typical of very low, broad dunes.

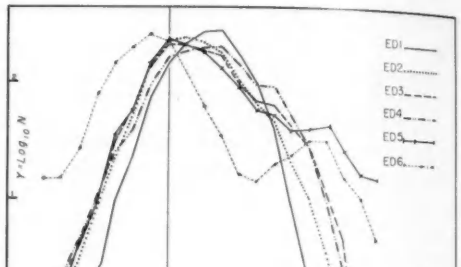

FIG. 16. Grain-size gradings of the ED series of samples. Unimodal gradings are characteristic of the crests of the higher dunes. Bimodal gradings are typical of very low, broad dunes.

and slope samples on both the coarse and fine sides of the peak, the similarity of the peak diameters must largely be discounted as a prop for the argument on blowout-mixing of sands. We may indeed go further and conclude that vegetation evidently plays a rather minor role in influencing the gradings of these sands, and that the earlier suggestion was erroneous.

The Grading of Sands in the Syracuse and Kendall Areas

The two remaining north-south sample transects, taken respectively to the south of Syracuse and Kendall (Fig. 14), show several gradings of a type not encountered in the CW series of crest and lower slope samples. The grading diagrams for the Syracuse and Kendall samples (Figs. 15 and 16) show the following features: (1) the crest samples taken within the true dunes (EA 1-4 and ED 1-4) have unimodal gradings with peak diameters (0.19 mm.) akin to those of the CW series, but with somewhat more regular and steeper gradings on both fine and coarse side than is typical of the northern CW samples; (2) the crest samples taken in the area mapped as the Vona Fine Sand in Figure 14 are mostly strongly bimodal sands, having the primary peak at 0.19 mm. and a much coarser secondary peak at about 0.80 mm. (samples EA 6, 7, and 10 and ED 5 and 6).[63]

The explanation for the greater regularity of crest samples from the true dunes in comparison with those in the northern CW samples is not readily apparent. The Syracuse and Kendall dunes are no higher than the northern belt of high dunes in the Garden City area, and to all appearances they have

[63] The area of Vona Fine Sand in Figure 14 is taken from the map accompanying the report by A. W. Goke, R. W. Eikleberry, C. L. Fly, and H. E. Myers, "Physical Land Conditions Affecting Use, Conservation, and Management of Land Resources, Hamilton County, Kansas," mimeographed, United States Department of Agriculture, Manhattan, Kansas, 1953.

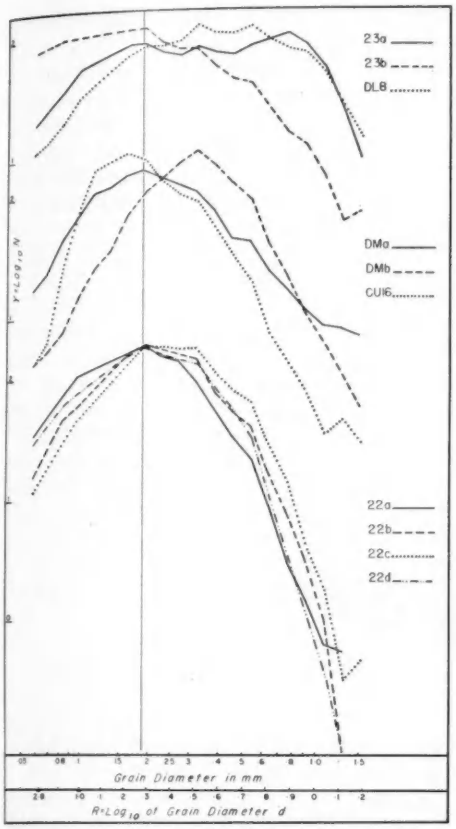

FIG. 17. Grain-size gradings of miscellaneous dune sands in the Syracuse-Ingalls dune area.

undergone all the same processes of dune blowout and fixation. It is conceivable, however, that the narrowness of the dune belt and a lesser volume of sand would enable more complete sorting to take place than in the CW series.

Although at first sight the bimodal grading of the Vona Fine Sand is also difficult of explanation, this difficulty is more apparent than real, for these sands give every indication of being slightly modified trough sands. The location of these sands is revealing (Fig. 14) in that all the Vona samples were collected from the crests of very low dunes, hardly more than gentle undulations, lying between higher dunes. The coarse mode in these sands would thus seem to be due to the presence of sands which are too large to climb the larger, steeper sided dunes and hence are confined to troughs and to areas of residual sands over which large dunes have migrated. This argument finds support in the gradings of known trough samples in the Garden City and Ingalls dune belts, two of which are given in Figure 17 (samples 23a and DL8) for comparison with the Vona Fine Sand samples: both trough samples have an abundance of coarse sand of the sizes required, and indeed have their primary peak between 0.60 and 1.00 mm.[64] The Vona Fine Sand samples thus clearly show the influence of two separate grading processes, one directed to the development of a peak comparable to that of the higher dunes (0.19 mm.) which is essentially a saltation peak, the other resulting from the addition of a surface creep deposit to give the second mode around 0.80 mm.[65]

Grading of a Barchan Near Kendall

About three miles south of Kendall a small area of sand nearly one mile square has escaped the hold of vegetation and now exists as free dunes which migrate northward. One of these free dunes, a barchan 20 feet high, was selected for sampling, to see whether its gradings followed those of other barchans reported in the literature. The approximate locations of the eleven samples on the barchan and their respective gradings are given in Figure 18 and in Table 4.

The peak diameter of all but two of the barchan samples—the exceptions are samples 2 and 8—is notably coarser than that in nearby vegetated dunes, the barchan samples having a peak of at least 0.32 mm., while the peak in the adjacent samples EA 4, 5, and 6 is 0.19 mm. These differences may result from either fundamental differences in the grading process on the two types of dune (assuming that the sand source for both is exactly the

[64] Bagnold, *The Physics of Blown Sand . . . , op. cit.*, pp. 228–229, notes that not only are very coarse grades typical of the trough areas, but also that the grading "is sometimes so wide that the sand contains grains of different sizes in nearly equal proportions over a great range of diameters." This is also true of samples 23a and DL8 in the present study area.

[65] Certain of the CW series of crest and slope samples also show a weak secondary peak within the range 0.60 to 1.0 mm., which is evidently a surface creep deposit. See, for example, samples CW (crests) 1, 6, 17, and 21, and CWS (slopes) 6, 16, 19, and 20.

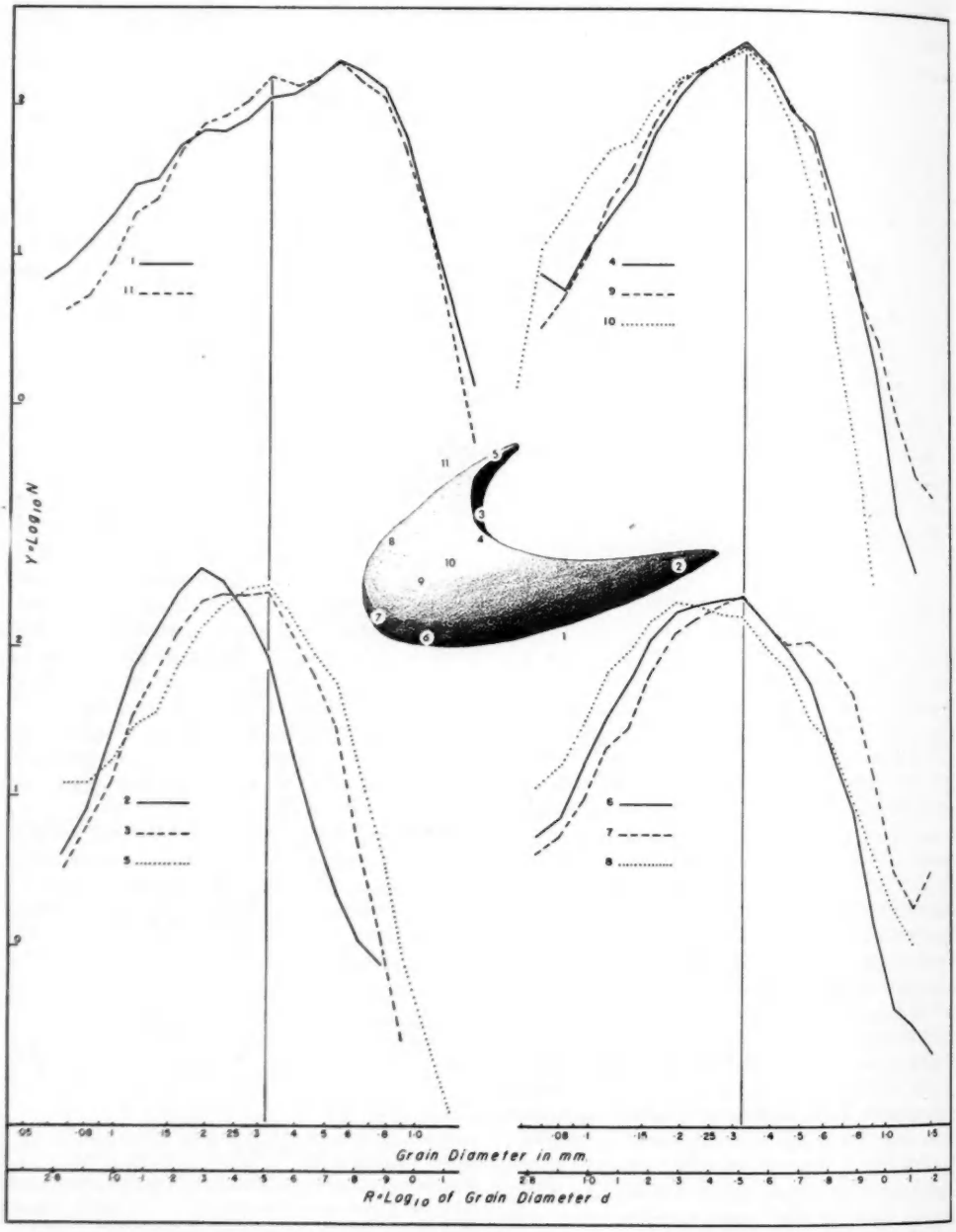

FIG. 18. Grain-size gradings of a barchan near Kendall. The peak diameters of most of the samples are coarser than the nearby EA series of vegetated dunes.

same), or there may be somewhat dissimilar sources for the dunes. Since the barchan undoubtedly taps deeper layers of sand denied the vegetated dunes, the latter possibility at first sight seems the more reasonable. An indication that this might be the case is to

be seen in the gradings of samples DMa and DMb (Fig. 17), collected to the south of Ingalls, which were taken at the same site, at depths of 8 and 13 feet below the surface of a low dune. The lower sample has a peak diameter of 0.32 mm., the higher of 0.19 mm. These gradings are of course no guarantee that a comparable change in grading with depth takes place at all sites in the dunes. Another series of samples (22a, b, c, and d in Fig. 17) collected at site CWS 22 south of Holcomb showed no significant change in the gradings at depths of 2, 5, 8, and 11 feet below the surface. In yet another site (samples 23a and b, Fig. 17) south of Holcomb, the grading of the surface sand in a trough was appreciably coarser than that only 4 feet from the surface.

These conflicting observations on the changes in grading with depth do not necessarily eliminate variations in the source sands in the barchan area as the reason for the coarser grading of the barchan compared with the vegetated dunes. However, they do lend some weight to the alternative suggestion that there may be fundamental differences in the grading process on the two types of dune. No convincing argument can be adduced in support of this suggestion, but at least the phenomenon is apparently not unknown elsewhere. Alimen, for example, found differences in the grading between a large sif dune and an adjoining small barchan near Ougarta in Algeria, even though in her opinion the sand source for the two dunes was identical.[66] Bellair also suggested, on the basis of some 250 grading analyses of dunes in Algeria and Fezzan, that there is a direct correlation between dune morphology and the grading of dune sands.[67] While there is some doubt as to the reliability of Bellair's conclusions, he does give some evidence of grading differences in relation to dune type.[68]

If there really are differences in the grading process on the two dune types, this may account for certain features of the grading of the CW series to the south of Holcomb. Figures 10, 11, 12, and 13 show that many of the CW gradings have a kink in the grading curve at 0.32 mm. and at least two samples (CW 5 and 12) have their prime peak at 0.32 mm. It is possible that this grading feature may be inherited from free dunes, once present in the Holcomb area.

In addition to having coarser peak diameters than the vegetated dunes the barchans also show the following grading features: (1) Girdling the lower portion of the dune on the windward side is a fringe of coarser grains with a peak diameter of 0.55 mm. which are evidently too heavy to climb the dune and have either been deflected around it (samples 1 and 11), or have been retarded on the rear of the dune (sample 7 shows some of the effects of these coarser retarded grains in the presence of a double peak at 0.32 and 0.55 mm.). This windward fringe of coarse sands is a well-known feature of barchan gradings and is discussed at length by both Bagnold and Verlaque.[69] (2) Two samples have fine peak diameters of 0.19 mm., and are located respectively at the tip of one of the horns of the dune (No. 2), and in the middle lower part of one side (No. 8). (3) Sample 6, which corresponds roughly to the location of sample 8 on the other side of the dune, shows a tendency to dual peaks at 0.19 and 0.32 mm. (4) It is notable that sample 5, located on one of the horns does not have a fine peak comparable to that seen in sample 2. (5) As would be expected in isolated free dunes which are subject to much wind winnowing, the gradings are quite regular, and the sands are markedly lacking in particles of dust and silt size (0.05 to 0.002 mm.). They also have a small but consistent amount of clay (Table 4). Microscopic examination of the sands shows the clay exists both as thin coatings around individual sand grains and as occasional separate aggregates of sand grain size.

These results are interesting when compared with work on other barchans. Sidwell

[66] See H. Alimen, "Variations Granulometriques et Morphoscopiques du Sable le long de Profils Dunaires au Sahara Occidental," *Colloques Internationaux du Centre National de la Recherche Scientifique*, Vol. 35 (1953), pp. 217–25.

[67] *Op. cit.*, p. 113.

[68] For example, Bellair states that longitudinal dunes have more than two maxima in the grading. Practically all other work in the Sahara indicates that longitudinal dunes frequently have unimodal sands.

[69] See Bagnold, *The Physics of Blown Sand . . . , op. cit.*, p. 227, and C. Verlaque, "Les Dunes d'Iu Salah," *Travaux de l'Institut de Recherches Sahariennes*, Vol. XVII (1958), pp. 11–37.

and Tanner found in barchans they studied near Lubbock, Texas, that the horns of the dunes contained finer sand than the rest of the dune, with a concentration of 60 to 80 percent of the sands between 0.125 mm. and 0.250 mm. Sidwell and Tanner argued:

> The streamlined mass of the dune caused the wind to take a divided path around it, resulting in the formation and perpetuation of the two points of the crescent regardless of grain size. Since the small grains, ⅛ mm. in diameter, are actually carried by the wind, they are more likely to veer with the wind currents than the heavier, larger grains ¼ mm., and would therefore occur on the horns of the crescent in significantly larger numbers. The [grading] patterns show this to be true.[70]

This explanation accounts reasonably for the fine peak noted in sample 2, which was taken on the outside of one of the horns in the Kendall barchan. The same explanation might be expected to apply, though less strongly, to sample 8 and possibly also sample 6, which were collected on the lower mid sides of the main mass of the barchan. On the other hand, sample 5, from one of the horns of the Kendall barchan is quite unlike sample 2. It more closely resembles sample 3, taken at the base of the central part of the slip slope, and samples 4, 9, and 10 on the crest of the barchan. Since sample 5 was taken on the slip-slope side of the stub of the horn this resemblance is not surprising. Not all winds blow exactly along the axis of the barchan, and any winds blowing at an angle to the axis would cause drifting of sands from the body of the dune along the inner arms of the horns, thus giving rise to slip-slope gradings typical of the main mass of the dune. In any case, as Bagnold has shown, the sand which falls over the crest must be diverted outwards along the inside of the arms of the crescent as a normal part of barchan growth, and this is true even with winds exactly parallel to the axis of the dune.[71]

The grading of the material composing isolated barchans in Libya, according to Bagnold, "is nearly homogeneous from the summit downwards to within a height above the ground of the order of 5 per cent of the summit. Below this there may or may not exist on the windward site, according to the nature of the surrounding country, a fringe of coarse grains and small pebbles whose slow movement has been held up by the dune."[72] As already noted, the Kendall barchan shows a tendency to finer sands along the lower sides of the dune (samples 8 and 6) than on the crest (samples 4, 9, and 10). Bagnold's generalization for the Libyan dunes would thus seem not to be applicable in western Kansas.

Homogeneity of sands is apparently not a feature of all barchans in other parts of the Sahara Desert. Alimen, for example, describes a small barchan near Ougarta in Algeria, with strongly bi-modal sands, in which the crest has significantly coarser sands than either the gentle windward slope or the abrupt lee face of the dune.[73] Bellair, on the other hand, presumably referring mainly to crest samples, states that almost all barchans in Algeria and Fezzan have well-graded sands with a single prominent peak, or with two maxima close together.[74] Verlaque's observations on a barchan some 40 feet high near In Salah, Algeria, are different again: the mass of the barchan was composed of sand smaller than 0.104 mm., but the crest sands were coarser and some were bi-modal; the gradings of the crest sands also varied strikingly, depending whether samples were taken from the crests of small ripples only one centimeter high (peak diameter 0.283 mm.) or from the troughs of the ripples (peak diameter 0.147 mm.).[75]

The Texas barchan studied by Sidwell and Tanner also showed marked variations in grading from one part of the dune to another. In particular, they noted that grains coarser than 0.25 mm. climbed the dune, but were deflected away from the crest under the action of gravity and diverging wind flow, and crossed the slip slope about half way from the axis to the horns. They considered that the width of the dune played an important part in this deflection (height may also be significant), stating that "the larger the dune, the more distinct will be the separation between the two accumulations of 0.25

[70] Sidwell and Tanner, *op. cit.*, pp. 182–83.

[71] Bagnold, *The Physics of Blown Sand . . . , op. cit.*, p. 212.

[72] *Ibid.*, p. 227.

[73] See Alimen, "Variations Granulometriques et Morphoscopiques . . . ," *op. cit.*, pp. 221–23.

[74] *Op. cit.*, p. 114.

[75] *Op. cit.*, pp. 19–29.

mm. grains, . . . [while] in an eighty foot [wide] dune the 0.25 mm. grains would accumulate immediately below the center of the crest."[76] If these observations in Texas hold true in other areas it would seem that diversity, not homogeneity, would be characteristic of the gradings of many barchans. Further work is needed to reconcile the preceding studies with one another.

CONCLUSIONS

At the beginning of this study the thesis was put forward that some of the most complex dune types and some of the more complex dune gradings might be found in the mid-continent steppes in dunes with a discontinuous grass and low shrub cover. To what extent have these expectations been realized in western Kansas?

In both form and origin the dunes between Syracuse and Cimmaron are indeed complex. The presence of an active sand-binding vegetation, numerous blowouts, and periodic free dune migration, coupled with reversals in wind direction in sympathy with the glacial advance and retreat of the Wisconsinan period have helped produce a jumbled, chaotic dune landscape. Although the dominant sand-moving winds of the present are from the south, the dunes were built largely by north winds which stripped sand from the Wisconsinan alluvials of the Arkansas River and to some extent reworked the pre-Peorian sands lying on the Kansan terrace where it was possible to scour away the Peorian loess mantle. The major advance southward over the Peorian loess involved the sand sources as noted above and may have started as early as late pre-Bradyan.

The expectation that the sand gradings might also be very complex in these dunes was not fully realized. Many features of the gradings agree quite closely with those of desert dunes in which vegetation has played no part in dune development. The improvement in regularity and in narrowness of grading with movement away from the source, the steeper grading on the fine side in the crest sites compared with the slopes, and the wide range of sand sizes and imperfect grading of the trough sands, all are as typical of desert dunes as of these vegetated dunes. In two major respects, however, the gradings may fairly be regarded as complex. The anomalous crest-slope relation in the northern CW series in which the coarse side grading of the slope sands is steeper and more regular than the crest sands is one feature which has apparently not been recorded of desert dunes. Also, the differences in peak diameters between the vegetated dunes and the Kendall barchan pose many questions which this study does not answer satisfactorily.

In addition to the above problems there are several others this discussion has touched upon which demand further study. There is already some evidence that very fine sands composed of particles within the range of 0.08 to 0.15 mm. do not behave in the same manner as coarser sands, particularly with respect to differences between crest and slope peak diameters. It is probable too that very coarse sands (from 0.5 to 2.0 mm.) may give rise to dune gradings unlike those of the majority of dunes which have their predominant diameter between 0.15 and 0.30 mm. Finally, while we may speculate on the role of dune height, and on the function of gravity slope sorting and of dune spacing in affecting gradings, it is all too evident that we are merely speculating. Studies aimed at quantifying the part played by these factors in dune gradings can no longer be deferred.

[76] Sidwell and Tanner, *op. cit.*, p. 185.

THE CHANGING DISTRIBUTION OF THE AMERICAN NEGRO[1]

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THE changing distribution of its Negro population has been one of the most dramatic aspects of the population geography of the United States over the last half century. In 1910 the Negroes of the United States were concentrated mainly in rural areas on the plains of the southeastern part of the nation, but by 1950 most of the nation's Negroes had left the rural areas, and many of them had left the South as well. In 1910 only one Negro in four lived in an urban place, and Negroes comprised only 6.3 percent of the urban population; by 1950 two thirds of the nation's Negroes lived in urban areas, and 9.7 percent of the urban population was Negro.

It is the purpose of this paper to examine and describe the changing patterns of Negro distribution in the United States. Insofar as possible these patterns are analyzed and interpreted, but they are so complex, both temporally and areally, that no one person could be fully competent to analyze them adequately, and in some instances the paper has had to be limited to descriptions of patterns rather than attempt interpretation.

In describing the redistribution of Negroes, this paper treats four separate but closely interrelated aspects of this redistribution: (1) the widely varying regional trends of growth and decline in the Negro population; (2) changes in the distribution of Negroes between 1910 and 1950, with a delimitation of the Negro area of the United States; (3) areal variations in the date of maximum Negro population; and (4) patterns of Negro migration in the decade 1940–50, with a discussion of techniques for measuring migration.

MAJOR TRENDS BY CENSUS REGIONS

The steady increase of the Negro population of the United States, from 757,208 persons in 1790 to 15,042,286 in 1950, has actually been the composite of widely varying regional trends. Only once, and in only one[2] of the nine census divisions, has there ever been an actual decline in the Negro population, but the rates and amounts of increase in the different divisions have shown considerable divergence.

For ready comparison, the number of Negroes in each division at each census has been calculated as a percentage of the national total at the time of the census (Fig. 1).[3] When examining this graph, one must remember that the 504,392 Negroes in the Pacific states in 1950 (only 3.3 percent of the national total) form a group almost as large as the total Negro population of the nation (757,208) in 1790. Similarly, although it has increased almost eightfold in actual size, the Negro population of the five South Atlantic states had declined from more than 70 percent of the national total in 1790 to less than 30 percent in 1950.

The regional redistribution of American Negroes occurred in three rather distinct periods, with major breaks at the censuses of 1860 and 1910. Between 1790 and 1860 the Negro population was expanding westward in the South, with a relative decrease in the Seaboard states. The period from 1860 to 1910 is one of relative stability in the Negro population distribution, with all census divisions increasing at approximately the same rate. In terms of interregional Negro migration this half century was essentially a slack tide between the great westward surge which had preceded it and the great northward diaspora which was to follow.

The years since 1910 have witnessed considerable relative increases in the Negro pop-

[1] Appreciation is expressed to Miss Helen Lightfoot, Documents Librarian at Indiana University, for the readiness with which she made out-of-print public documents available; to George F. Jenks, University of Kansas, for cartographic suggestions; and to Robert C. Kingsbury, Indiana University, for editorial advice and assistance.

[2] The East South Central, which dropped from 2,780,635 Negroes in 1940 to 2,698,635 in 1950 for a loss of 82,000. It should also be noted, however, that the West South Central division's increase of 6,907 Negroes between 1940 and 1950 was only 0.3 percent of the division's 1940 Negro population.

[3] As their Negro population trends are essentially similar, Delaware, Maryland, and the District of Columbia have here been combined with the New England and Middle Atlantic divisions as the Northeast, and the curve for the South Atlantic region represents only the Negro population of Virginia, the Carolinas, Georgia, and Florida.

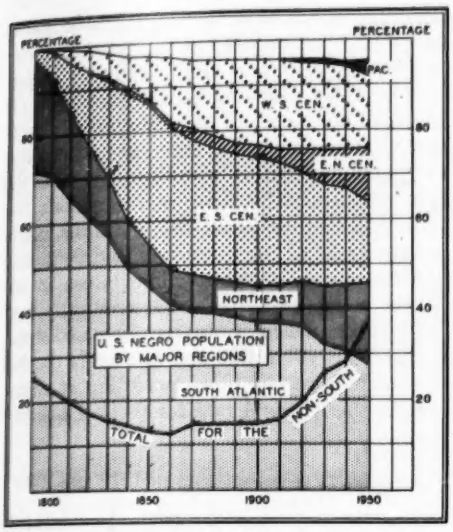

FIG. 1. The number of Negroes in each major region of the United States as a percentage of the national total, 1790–1950. The regions are essentially the geographic divisions used by the Bureau of the Census, except that the Northeast includes Delaware, Maryland, and the District of Columbia in addition to the New England and Middle Atlantic divisions, and the South Atlantic region includes only Virginia, the Carolinas, Georgia, and Florida.

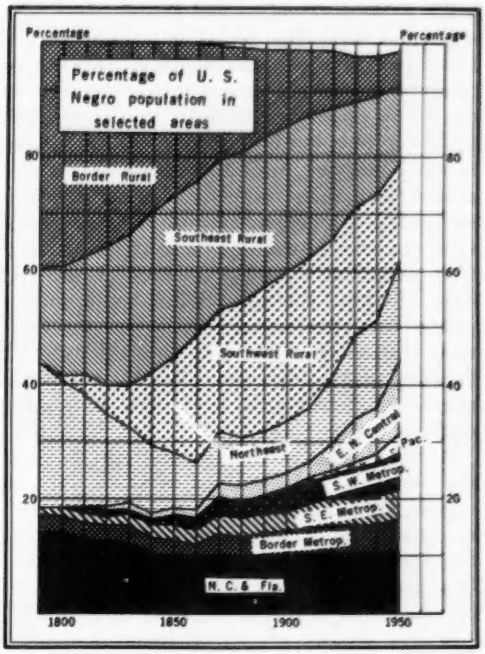

FIG. 2. Percentage of the Negro population of the United States in selected areas at each census, 1790–1950. The Border includes Virginia, Kentucky, Tennessee, and Missouri; the Southeast includes South Carolina, Georgia, and Alabama; the Southwest includes Mississippi, Arkansas, Louisiana, Texas, and Oklahoma; the Northeast includes the New England and Middle Atlantic divisions plus Delaware, Maryland, West Virginia, and the District of Columbia; the East North Central and Pacific divisions are as defined by the Bureau of the Census.

ulation of the Northeastern and East North Central states, and sharp relative decreases in the South. Although this trend is apparent in the regional curves, it is emphasized by the heavy trend line across the lower part of the graph, which represents the total Negro population of all states outside the South. Since 1910, but only since 1910, the South's share of the nation's Negroes has declined strikingly.

This graph also indicates the existence of an interesting reciprocal relationship—insofar as the Negro population is concerned—between three pairs of regions, with one member of each pair in the South and the other outside (Fig. 1). The percentage of the nation's Negroes in each pair of regions has remained surprisingly constant, but the share of the region in the South has declined as the share of the nonsouthern region has increased. Since 1890, for instance, 47 percent of the Negroes of the United States have lived in the combined Northeastern and South Atlantic states, and the relative increase of the Negro population of the Northeast has exactly balanced the relative decrease in the South Atlantic states. The East North Central states have a similar relationship with the East South Central states, and the Pacific states with the West South Central states.

Although this graph illustrates important trends in the Negro population of the South in relation to the nation as a whole, it does not adequately emphasize divergent Negro population trends within the South. These trends are shown quite clearly, however, when data for the Negro population of various areas within the South are regrouped in terms of the date of maximum Negro population (Fig. 2). Although it anticipates material to be discussed in detail later in this paper, the graph itself must be considered here because of the light it casts on gross patterns of Negro redistribution within the South.

First, North Carolina and Florida should be separated from the remaining states of the Southeast, because the Negro population of these two states has grown at the same rate as the Negro population of the nation since 1860. Then the four border states of Virginia, Kentucky, Tennessee, and Missouri should be separated from their respective census divisions and grouped together, because the majority of rural counties in each of these states attained their maximum Negro population at an early date. Finally, throughout the South metropolitan counties should be separated from their respective states and grouped together because of the divergent Negro population trends in metropolitan and nonmetropolitan counties in the South.

Although this second graph fails to show the reciprocal relationships between pairs of regions at the national level, it emphasizes two major aspects of Negro redistribution within the South: (1) the northern margin was the first part of the South to lose a significant proportion of its Negro population, and (2) the Negro population of metropolitan areas in the South continues to increase, both relatively and absolutely, whereas the Negro population in most other parts of the South is declining.

The rural portions of the border states did not reach their maximum Negro population until 1880, but the relative importance of their Negro population has declined steadily since 1790, when they had almost two fifths of the nation's Negroes, until 1950, when they had only 6 percent (Table 1, Fig. 2). The rural portions of the Southeastern states had 17 percent of the nation's Negroes in 1790, increased steadily until 1850, when they reached a peak of 28.5 percent, and subsequently have decreased just as steadily, until in 1950 they had only 14 percent. Their maximum Negro population was reached in 1910; since then their Negro population has declined absolutely as well as relatively. The rural portions of the Southwestern states had their maximum Negro populations in 1940, but their percentage of the national total has been on the wane since 1910. In all three areas the effects of under-enumeration in rural areas at the census of 1870 are quite apparent.

The Negro population of the Northeastern and East North Central states has grown steadily, both absolutely and in percentage, since the Civil War, and the Pacific states, which had had only 0.3 percent of the nation's Negroes in 1910, had mushroomed to 3.3 percent by 1950. Unlike adjacent rural areas, the metropolitan areas of the Southwest, Southeast, and border states have been increasing in Negro population steadily ever since the first censuses. The share of the nation's Negroes has also increased steadily in the metropolitan areas of the Southwest and Southeast, but the share of metropolitan areas in the border states grew somewhat erratically until 1870; subsequently it also has increased steadily. In North Carolina and in Florida the Negro population has been increasing at almost exactly the national rate for the last hundred years.

DISTRIBUTION OF NEGROES IN 1910 AND 1950

The distribution of the Negro population in 1910 is of considerable importance. On the regional level it was essentially where it had been for some fifty years, albeit thicker on the ground. The massive northward migration was about to start, but had not yet gotten under way. In short, the census of 1910 records the high tide of the rural Negro in the South, and any comprehension of the subsequent redistribution must be based on an understanding of the situation in 1910.[4]

The distribution of Negroes in 1950 provides a useful basis for comparison with the 1910 distribution, and also, despite the more recent data of the 1960 census of population, it merits consideration in its own right. The turbulent decade of 1940–50 witnessed the greatest Negro redistribution, both relatively and absolutely, that has ever been recorded in the United States. Existing trends were intensified by wartime mobilization and industrialization, and by 1950 every major metropolitan area had a sizable Negro population.

When considering the distribution of Negroes—or any other minority group—in the United States, neither density per square mile nor percentage of Negroes in the total population is a completely satisfactory index, if

[4] With almost uncanny prescience, after completion of the census of 1910, the Bureau of the Census sponsored a monumental study of the Negro: John Cummings, *Negro Population, 1790–1915* (Washington: Government Printing Office, 1918).

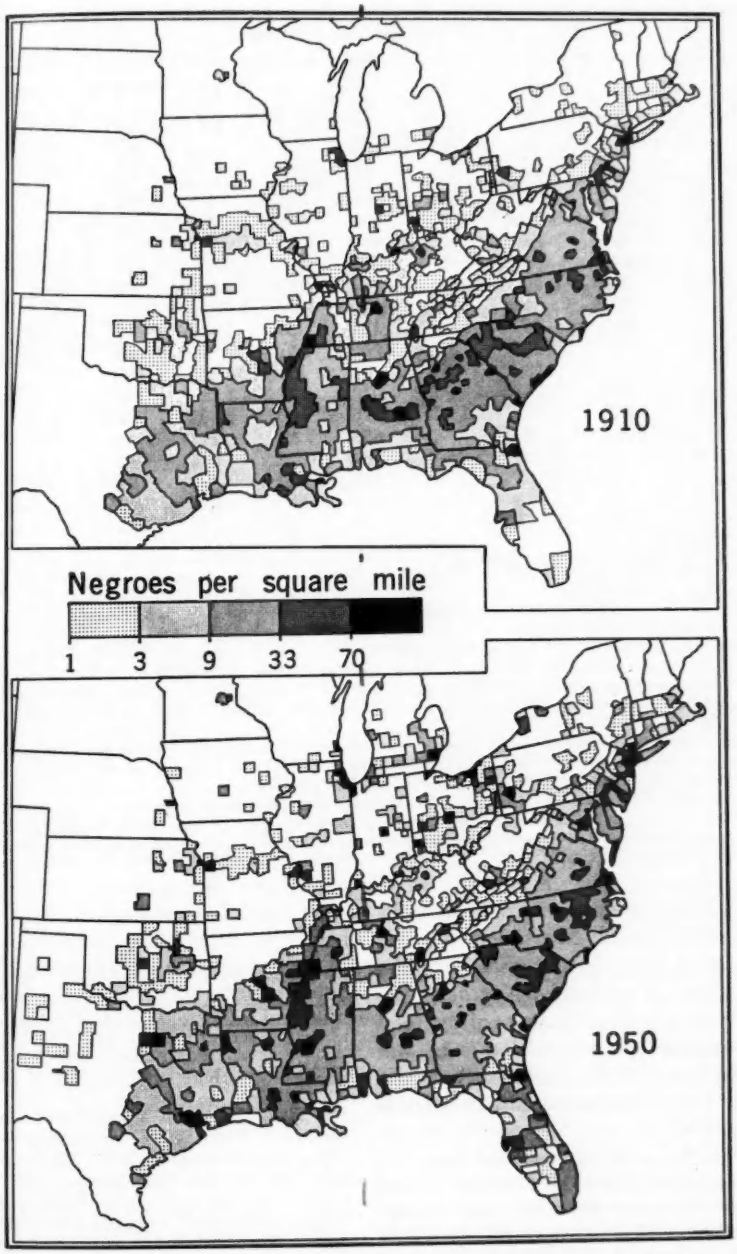

FIG. 3. Negroes per square mile in 1910 and in 1950. A density of more than 70 per square mile indicates a major Negro community in an urban area; contiguous counties with more than 33 per square mile have dense rural Negro population, whereas isolated counties with this density are urban, for the most part; a county with a density of less than 9 will have less than 3 Negro families per square mile; and one with a density of less than 3, less than one family.

TABLE 1.—NUMBER OF NEGROES IN SELECTED AREAS OF THE UNITED STATES, 1790–1950[1]
(THOUSANDS OF PERSONS)

Year	U. S. Total	Northeast	East North Central	Pacific	Border Non-metrop.	Border Non-metrop.	Southeast Non-metrop.	Southeast Metropolitan	Southwest Non-metrop.	Southwest Metropolitan	North Carolina and Florida
1950	15,042	2,844	1,804	504	906	858	2,098	767	2,487	931	1,650
1940	12,866	2,013	1,069	134	938	690	2,226	656	2,800	700	1,328
1930	11,891	1,701	930	90	959	619	2,224	586	2,696	595	1,226
1920	10,463	1,149	515	48	1,026	530	2,480	492	2,565	433	1,092
1910	9,828	905	301	29	1,101	462	2,498	423	2,615	379	1,007
1900	8,834	781	258	15	1,180	407	2,293	351	2,306	297	855
1890	7,489	623	207	14	1,154	330	1,947	279	1,896	225	727
1880	6,581	551	183	7	1,200	251	1,730	199	1,548	190	658
1870	4,880	439	130	5	977	198	1,282	155	1,035	148	484
1860	4,442	363	64	4	1,070	117	1,213	103	997	84	425
1850	3,639	349	45	1	975	109	1,032	92	612	68	356
1840	2,874	328	29	–	858	80	811	64	365	46	296
1830	2,329	312	16	–	787	72	615	47	171	26	281
1820	1,772	285	8	–	635	50	430	28	94	21	220
1810	1,377	272	3	–	515	40	288	20	47	12	179
1800	1,002	226	1	–	393	28	196	13	4	–	140
1790	757	191	–	–	299	23	129	10	–	–	106

[1] Definition of areas: The East North Central area and the Pacific area are the geographic divisions used by the Bureau of the Census.

The Northeast includes the New England and Middle Atlantic geographic divisions plus the states of Delaware, Maryland, West Virginia, and the District of Columbia.

The Border includes the states of Virginia, Kentucky, Tennessee, and Missouri. The Border Metropolitan area includes Jackson County, St. Louis County, and St. Louis City in Missouri, Fayette and Jefferson counties in Kentucky, Davidson, Hamilton, Knox, and Shelby counties in Tennessee, and Arlington, Fairfax, Henrico, Norfolk, Princess Anne and Roanoke counties in Virginia, in addition to the independent cities of Alexandria, Norfolk, Portsmouth, Richmond, Roanoke, and South Norfolk in Virginia.

The Southeast includes the states of South Carolina, Georgia, and Alabama. The Southeast Metropolitan area includes Greeneville and Richland counties in South Carolina, Bibb, Chatham, De Kalb, Fulton, Muscogee, and Richmond counties in Georgia, and Etowah, Jefferson, Mobile, and Montgomery counties in Alabama.

The Southwest includes the states of Mississippi, Arkansas, Louisiana, Oklahoma and Texas. The Southwest Metropolitan area includes Hinds County in Mississippi, Pulaski County in Arkansas, Caddo, East Baton Rouge, Jefferson, and Orleans parishes in Louisiana, Oklahoma and Tulsa counties in Oklahoma, and Bexar, Dallas, Galveston, Harris, Jefferson, McLennan, Tarrant, and Travis counties in Texas.

used alone.[5] Some urban areas, for example, have almost astronomical Negro densities; yet the percentage of Negroes in the total population is quite low. Conversely, Negroes comprise an extremely high percentage of the total population in some sparsely settled areas; yet there may be less than one Negro person per square mile. It is necessary, therefore, to consider both indices in order fully to comprehend the distribution of Negroes.

The major area of Negro population in the United States in 1910 was a belt some two hundred miles wide which spanned the plainsland South[6] from the Black Prairies of Texas to Virginia, and then tapered to a narrow tip

[5] Although the term "density" is universally accepted for describing the concept of number of units per unit of area, there appears to be no equally suitable and generally accepted term for the concept of proportionality, such as the percentage of Negroes or of older persons. It is suggested, therefore, that the term "intensity" might be used in describing the concept of the percentage of components of a population. Hereafter in this paper the term "Negro intensity" will be considered synonymous with "percentage of Negroes in the total population."

[6] "Plainsland South" appears preferable to the more common "deep South" or "lower South," and is rather less cumbersome than "Piedmont and Atlantic and Gulf Coastal Plain Physiographic Provinces" as a name for that part of the South in which level to rolling topography, a sizable rural Negro population, and an agricultural economy dominated by production of cotton or tobacco are more or less co-extensive. The plainsland South is quite different from the "hillland South" of the Blue Ridge, Ridge and Valley, Appalachian Plateau, Interior Low Plateau, Ozark, and Ouachita Physiographic Provinces, in which a predominantly native white population practices "general farming" in areas of hilly topography.

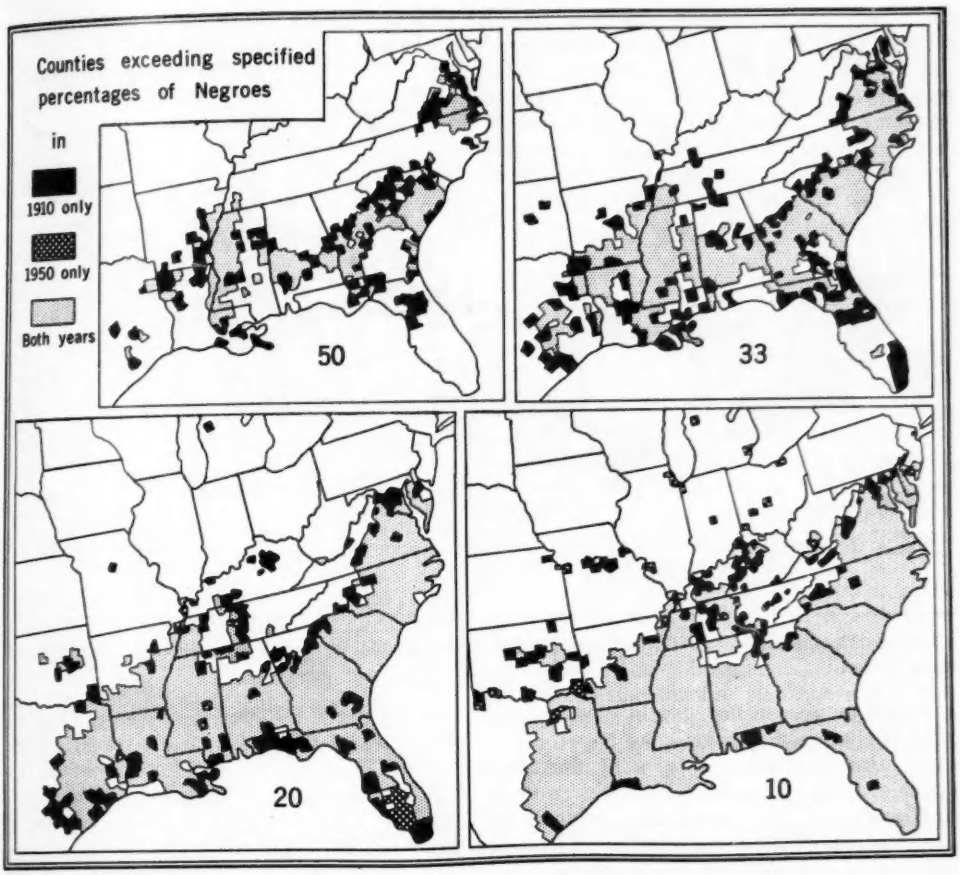

FIG. 4. Counties in which more than 50, 33, 20, and 10 percent of the total population were Negroes in 1910, in 1950, and in both years.

in Megalopolis (Fig. 3). This belt widened perceptibly where it crossed the Mississippi River bottomlands, sent a finger curling into northern Florida, and had outliers in the middle Tennessee River Valley–Nashville Basin–Pennyroyal Plain area and in the Kentucky Bluegrass. The greatest rural densities within the belt were in the Mississippi Delta country, in the Black Belt, on the Piedmont of Georgia and South Carolina, and on the Inner Coastal Plain of South Carolina. Relatively few counties had urban densities of more than 70 Negroes per square mile, and urban Negro communities in the Middle West were still relatively small.

Southern Florida and the Appalachian uplands had few Negroes in 1910, but there was more than one Negro per square mile in western Tennessee, western Kentucky, and the part of southwestern Ohio which centers on the old Virginia Military District. There were two or three Negro families per square mile along the lower Missouri River, in the eastern part of the new state of Oklahoma, and along the Gulf Coast. Farther afield only Chicago and Pittsburgh had more than 33 Negroes per square mile, but there was a hint of things to come in the increasing Negro population of many northern cities, especially those in the Pittsburgh-Cleveland area.

Two major changes are apparent in 1950: the shrinkage of the major belt and the increased number of counties with urban densities (Fig. 3). The number of urban Negroes

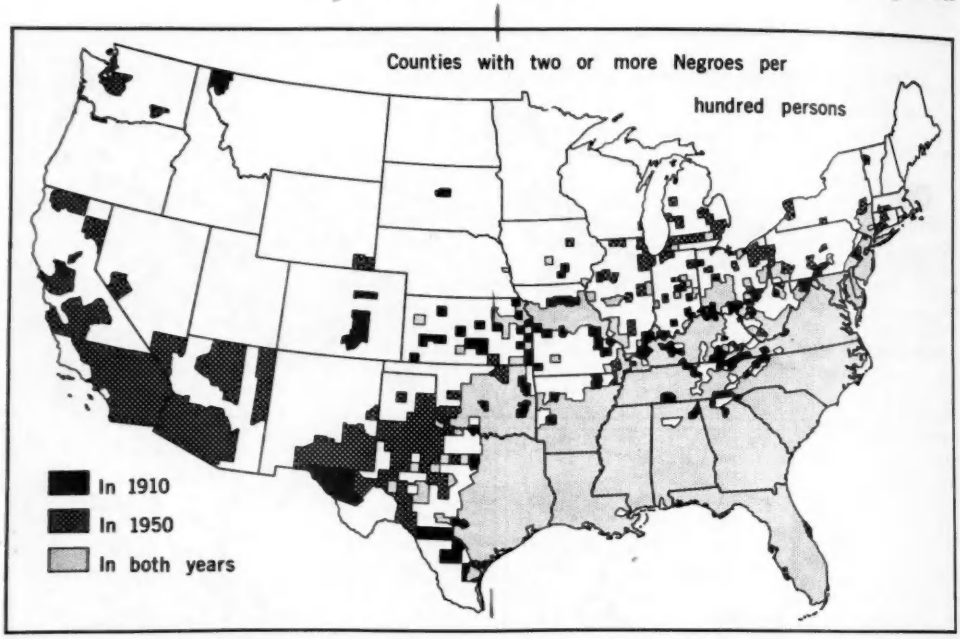

FIG. 5. Counties in which at least two percent of the population were Negroes in 1910, in 1950, and in both years.

increased notably in the Middle West and the trans-Mississippi South, and the Negro population also increased in parts of the High Plains of Texas, western Oklahoma, peninsular Florida, and the Inner Coastal Plain of the Carolinas. But there were fewer Negroes in much of eastern Texas, in the southern Appalachians, and in three areas which had a dense rural Negro population in 1910: The Mississippi Delta, the Black Belt, and the Piedmont of Georgia and South Carolina.

The same broad patterns are revealed by maps of Negro intensity (Fig. 4). In 1950 the counties which were more than half Negro were concentrated in the Mississippi Delta, in the Black Belt, on the Piedmont of Georgia and South Carolina, on the South Carolina Coastal Plain, and in areas centering on the peanut country of Virginia–Carolina and Georgia–Florida. The large number of counties which dropped out of this category between 1910 and 1950 are scattered throughout the South, but the greatest losses were in areas isolated from the main belt, or along its fringes.

The counties in which at least one-third of the population was Negro tend to fill the interstitial areas of the preceding pattern (Fig. 4). The largest additional areas are in eastern North Carolina, northern Florida, southern Arkansas, Louisiana, and eastern Texas. The counties which dropped below this percentage between 1910 and 1950 are almost entirely peripheral, with the largest number in the Piedmont, northern Florida, Louisiana, and Texas.

Virtually the entire plainsland South, from Texas to southern Maryland, had at least one Negro for every five persons in 1910 (Fig. 4). The small outlying areas in which Negroes comprised at least 20 percent of the total population included the Kentucky Bluegrass, the Middle Tennessee River Valley–Nashville Basin–Pennyroyal Plain area, and east central Oklahoma, but these areas had shrivelled considerably or even completely disappeared from the map by 1950. Otherwise, as in the two higher percentage categories, the counties whose Negro intensity dropped below the 20 percent mark between 1910 and 1950 were strung along the margins of the main area. This is the highest percentage category, however, to which counties were added between 1910 and 1950, with the major area of

TABLE 2.—NEGRO POPULATION IN SELECTED STATES, 1950

State[1]	Negro population	
	In selected urbanized areas	Elsewhere in state
California (7)	402,281	59,891
Washington (2)	19,870	10,821
Arizona (1)	13,406	12,568
Colorado (1)	15,611	4,566
Nebraska (1)	17,011	2,223
Oregon (1)	10,664	865
Minnesota (1)	12,561	1,461
New Mexico		8,408
Nevada		4,302
Utah		2,729
Wyoming		2,557
Montana		1,232
Idaho		1,050
South Dakota		727
North Dakota		257
Total	491,404	113,657

[1] Numbers in parentheses indicate the number of urbanized areas included in the calculation.

accretion in southern Florida. It is also noteworthy that, with the exception of Lake County, Michigan, and Howard County, Missouri, there has been no county outside the traditional South in which more than 20 percent of the population is Negro.[7]

Apart from the upland areas, in virtually every county in the South in 1910 at least one person in ten was a Negro (Fig. 4). There was little change on the plains between 1910 and 1950, but along the margins of the uplands the Negro intensity dropped below 10 percent in many counties. It is much more significant, however, that in the same period, between 1910 and 1950, the number of Negroes exceeded 10 percent of the population in many northern cities, including Chicago, Detroit, Indianapolis, Cincinnati, Columbus, Cleveland, Philadelphia, and Newark. Parenthetically it might be noted that in 1950 Negroes comprised exactly 10.0 percent of the population of the United States.

Approximately half the counties of the United States had two or more Negroes per hundred persons in 1910 or in 1950, if not in both years (Fig. 5). The South is so solid that the main interest lies in those counties whose Negro numbers have climbed above or dropped below the 2 percent level. Most of the losses are in the border area, and they call attention to the early role of the Missouri and Ohio rivers in the distribution of American Negroes. Although the Negro population has declined along the Ohio, at one time that river was lined, as the lower Missouri still is, by counties in which at least one person in fifty was a Negro.

The great majority of counties whose Negro population surpassed the 2 percent level between 1910 and 1950 are in the North and in the southern part of the West. North of the Ohio River and the Mason-Dixon line all but a few of these counties contain a major urban center. In the West, however, the pattern is complicated by the large size and sparse population of many counties. In western Texas, for instance, many counties have fewer than 10,000 people, and 2 percent of the population is only 200 persons.

Despite the appearance of the map, to the north and west of a line from San Antonio through Kansas City to Milwaukee the Negro population actually is highly localized (Table 2). Fifteen states in this area had a total Negro population of more than 600,000 persons in 1950, but over four fifths of the total number lived in only thirteen urbanized areas, and well over half lived in the Los Angeles and San Francisco urbanized areas. Outside the thirteen urbanized areas the total Negro population of these fifteen states is far less than half the Negro population of the eleven counties between the Mississippi and Yazoo rivers in the Mississippi Delta country.

But whereas the percentage of Negroes has been increasing in other parts of the nation, the Negro population intensity has been decreasing in the South (Table 3). Fewer counties had extremely high percentages of Negroes in 1950 than in 1910, but at the lower percentage levels there were about the same number. For example, the number of counties in which more than half the population was Negro dropped from 285 to 163, but the number of counties with more than three Negroes per hundred persons rose from 1211 to 1244.

THE NEGRO AREA IN 1950

Combining density and intensity criteria into a single index provides a better understanding of the relative importance of the Ne-

[7] For a discussion of the Negro population of Lake County, Michigan, see John Fraser Hart, "A Rural Retreat for Northern Negroes," *Geographical Review*, Vol. 50 (April 1960), pp. 147–68.

TABLE 3.—TOTAL NUMBER OF COUNTIES WITH NEGRO POPULATION EXCEEDING OR EQUALLING A SPECIFIED PERCENTAGE OF THE TOTAL POPULATION[1]

Percentage	1910	1950
90	3	0
80	29	4
70	90	28
60	165	76
50	285	163
40	421	272
30	561	430
20	736	586
10	912	832
8	966	905
7	1007	950
6	1052	1007
5	1112	1078
4	1168	1168
3	1211	1244
2	1350	1313

[1] County areas as of 1950.

gro population of the United States than can be gained by the use of either criterion alone. From the previous discussion one may conclude that the Negro area of the United States includes those counties which meet two criteria: (1) a density of at least one Negro per square mile, and (2) an intensity of at least 2 percent. Negroes patently are of minimal importance in counties which fail to meet both these criteria.

Within the Negro area one must recognize a core of counties in which the density is at least nine Negroes per square mile, and in which at least 20 percent of the people are Negroes. Furthermore, there are two types of counties intermediate between the core of the Negro area and those outlying areas which barely meet the criteria for inclusion. Many highly urbanized counties have a density of more than nine Negroes per square mile, but an intensity of less than 20 percent; conversely, numerous sparsely settled counties have an intensity greater than 20 percent but fewer than nine Negroes per square mile.

The core of the Negro area in 1950 swings in a great arc across the plainsland South from eastern Maryland to eastern Texas (Fig. 6). There are scattered outliers in Texas, Florida, and the area extending north and south through Nashville, but the core consists of a group of impressively contiguous counties. The sparsely settled counties of the Negro area—those with low densities and high intensities—are largely in eastern Texas, Florida, and along the Gulf Coast near Mobile Bay. Conversely, the counties with high densities and low intensities, which are the highly urbanized portions of the Negro area, lie north of the core area. The largest concentration is in Megalopolis, but there are smaller clusters in the Pittsburgh–Cleveland area, in the Detroit–Chicago area, in southwestern Ohio, and on the Piedmont of Georgia and North Carolina.

Some counties of the lowest category are scattered through the core of the Negro area, but for the most part the counties of this category lie around the margins of the area or are completely separated from it. They are strung along the Great Valley, from Hagerstown to Birmingham, and festoon the eastern front of the Blue Ridge from Virginia to Georgia. They cover much of northern Alabama, middle Tennessee, and western Kentucky, and extend northward into the old Virginia Military District of Ohio. Farther west they are found along the lower course of the Missouri River, in central Oklahoma, in eastern Texas, and scattered over the High Plains. And there are a number of counties in this lowest category on the West Coast.

For the most part, those counties which were in a lower category in 1950 than in 1910 are those which were in the lowest category in 1950, or had dropped completely out of the Negro area (Fig. 7). There was a decline throughout the uplands; the Blue Ridge Mountains, the Appalachian Hills, the Highland Rim–Pennyroyal Hills, and the Ozark-Ouachita borders are all areas in which the Negro population was of less importance in 1950 than in 1910. Interestingly enough, however, the Great Valley held its own, as did several other more favorable areas in the hill country. There was also a decline in many counties of the western South, and along the Gulf Coast, with concentrations in south central Texas, the marshlands of southern Louisiana, and the flatwoods country east of Mobile Bay and in southeastern Georgia and northern Florida.

The Negro area of 1910 lay almost entirely to the south and east of a line from New York City to Kansas City, and thence to San Antonio, and the Negro redistribution after 1910 might almost be described as an eruption across this line. The analogy is strengthened

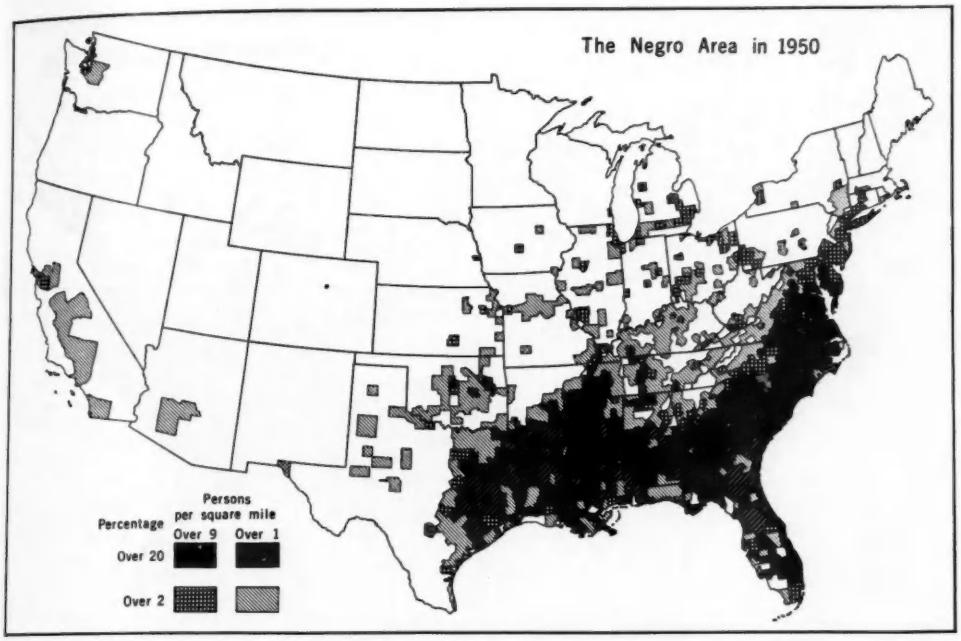

FIG. 6. The Negro area, as here defined, includes all counties with at least one Negro per square mile in which Negroes comprise at least two percent of the total population. The core of the Negro area includes only those counties in which there are at least nine Negroes per square mile and in which Negroes comprise at least a fifth of the total population.

by the way in which counties of a higher category in 1950 than in 1910 are splattered across the map; they are on the West Coast, in the western part of the South, in the North, and in Florida. There is a cluster in southern Missouri, several in coal-mining areas of Kentucky and West Virginia, and one on the industrial Piedmont of North Carolina.

But most impressive of all, perhaps, is the fact that such a large proportion of the counties of the Negro area were in the same categories in 1950 as they had been in 1910. Although there was some attrition of counties along its northern fringes, the core area in particular remained remarkably stable, and so did the sparsely settled areas of eastern Texas and northern Florida. This is not to say, quite obviously, that there were no changes, because there were many and they were far-reaching, but it does indicate that the Negro area as here defined, and its core in particular, had a considerable degree of stability between 1910 and 1950.

CENSAL YEAR OF MAXIMUM NEGRO POPULATION

Although 1910 is a critical year for any general consideration of Negro redistribution in the United States, it would be foolhardy not to assume that other years might be equally critical in various parts of the nation. It seems logical, therefore, to discover whether there actually is any great variation in the censal year in which various counties attained their maximum Negro population, and if so, to determine whether these variations have any areal significance.

Deciding the areal extent of the area to be investigated poses an immediate problem. Although the Negro area has shown a surprising degree of areal stability between 1910 and 1950, there still have been enough changes to warrant extension of the investigation beyond its outer limits. On the other hand, there seems little point in extending the investigation to the entire nation, as the Negro population of a large number of counties has always been small and subject to fairly great fluctua-

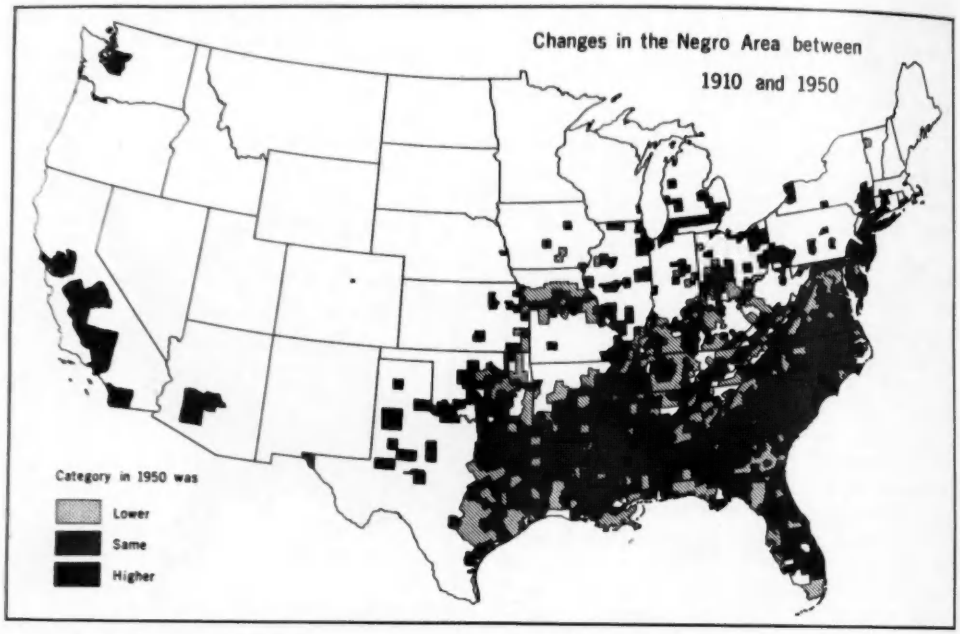

FIG. 7. Changes in the Negro area between 1910 and 1950. This map must be compared with Fig. 6, which shows the distribution, as of 1950, of the counties in the high category, the two intermediate categories, and the low category.

tions; the censal year of maximum Negro population for these counties would be almost meaningless.[8] After some experimentation, it became evident that the requirements of this study would be satisfied if the investigation included all counties which at some time have had a Negro population density of at least one person per square mile.

The question of the censal year in which to begin the investigation was easily answered by the notorious differential under-enumeration of Negroes in the South in the ninth census in 1870. Some years afterward Francis A. Walker, who had been superintendent of the ninth census, told a legislative committee:

> When the appointments of enumerators were made in 1870 the entire lot was taken from the Republican Party, and most of those in the South were Negroes. Some of the Negroes could not read or write, and the enumeration of the Southern population was done very badly. My judgment was that the Census of 1870 erred as to the colored population between 350,000 and 400,000.[9]

The first step in investigating the censal year of maximum Negro population, therefore, was the preparation of a map of the maximum Negro population density attained by each county in any census between 1880 and 1950 (Fig. 8). This map holds relatively few surprises. A few counties are added in New England, and there are minor accretions all along the upland margins. There are also a number of marginal counties with higher densities than they had in 1910 or in 1950, but no large blocks of counties are added to the areas already considered previously. Furthermore, the counties west of the 100th meridian were so uniform in attaining their peak Negro population in 1950 that they were omitted from fur-

[8] An excellent illustration is provided by Chittenden County, Vermont, whose Negro population soared from 153 in 1900 to 1,114 in 1910, then dropped abruptly to 175 in 1920, and has never exceeded 208 persons at any other time. The explanation apparently has to do with the stationing of Negro troops at Fort Ethan Allen.

[9] As quoted in James P. Munroe, *A Life of Francis Amasa Walker* (New York: Henry Holt, 1923), p. 113. Although great improvements have been made since 1870, partisan considerations still play too large a role in the appointment of enumerators.

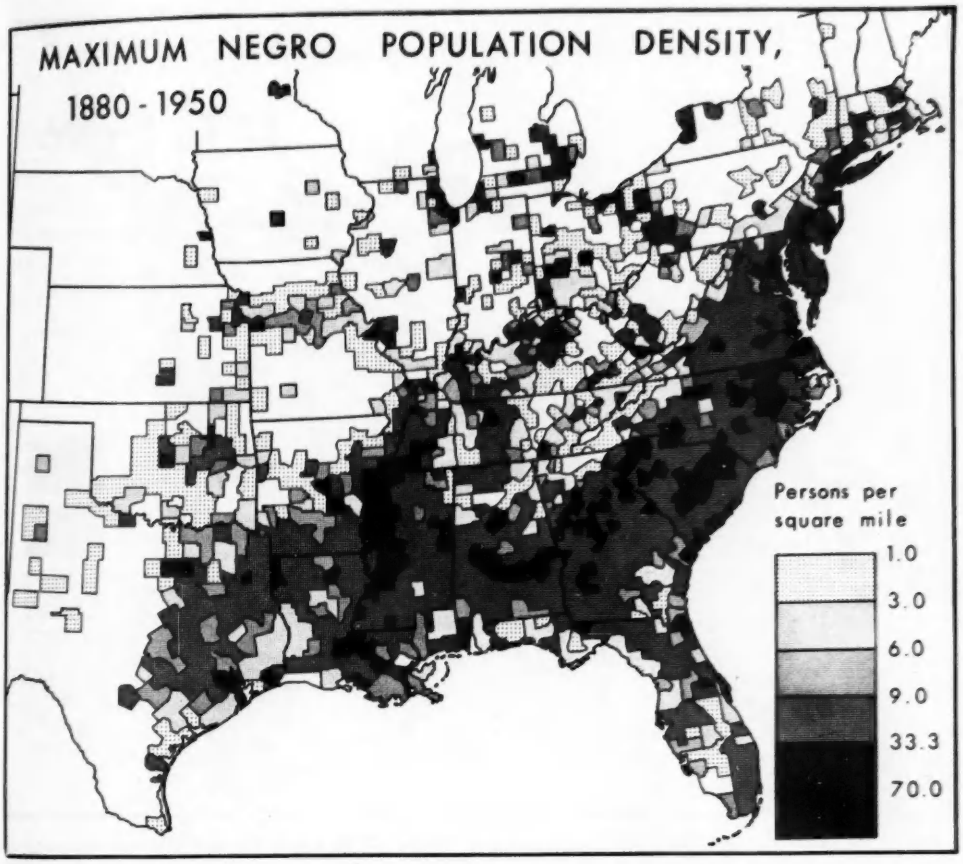

FIG. 8. Density of Negro population in the year of maximum Negro population at any census between 1880 and 1950.

ther consideration, and the investigation was restricted to the eastern portion of the country.

It soon became apparent that the maximum Negro population was attained almost simultaneously in large contiguous groups of counties with an impressive degree of regional concentration (Fig. 9). The peak was reached at a surprisingly early date in the four border states of Missouri, Kentucky, Tennessee, and Virginia, where large numbers of counties had their maximum Negro population in 1880 or in 1890. These counties are concentrated in the lower Missouri valley, in middle Tennessee and middle and western Kentucky—including most of the Bluegrass and Nashville Basins—in southwestern Ohio, in the Great Valley, and on the Virginia Piedmont. This period was the Negro high tide in the central hilly belt of the eastern United States, and by 1950 Negroes had almost disappeared in many of these counties.

In 1900 many additional counties around the margins of the hills attained their maximum Negro population, but this year is more notable because a few plainsland counties also reached their peaks. They are strung along the Fall Line in Georgia, a dozen are in the Alabama Black Belt, a few are along the lower Mississippi River, and some sixteen are in southern East Texas. But in 1900 the Negro population of most of the Cotton South was still growing.

The tide turned in 1910 and in 1920. Perhaps the boll weevil was pushing Negroes off

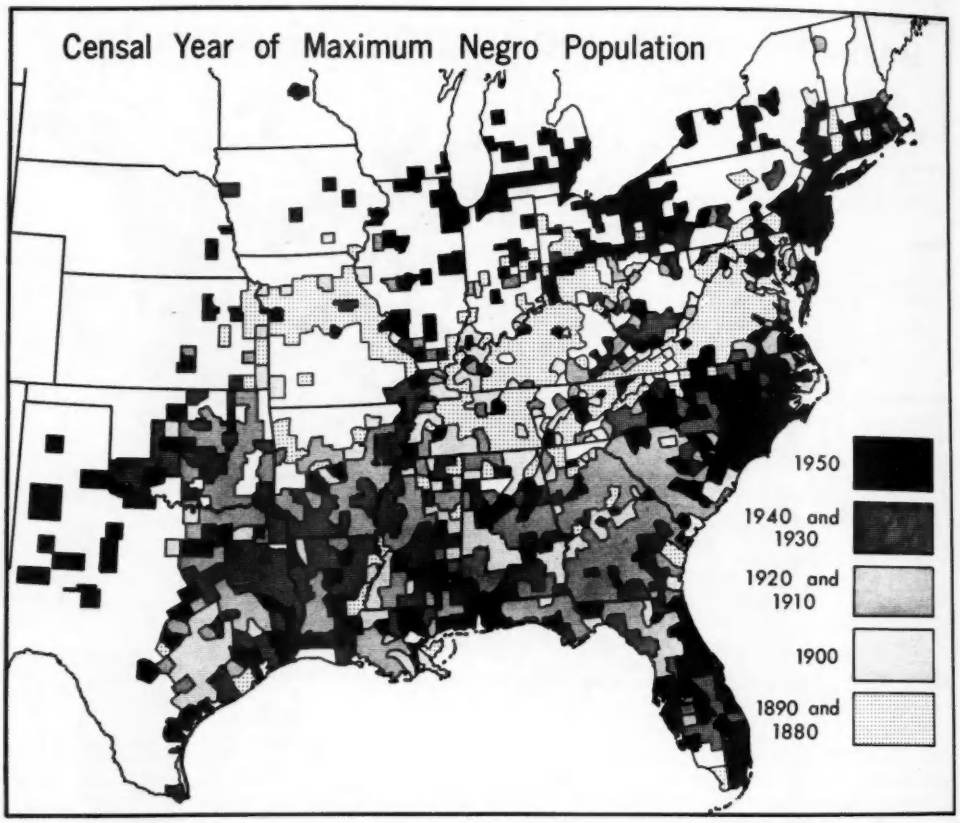

FIG. 9. Censal year of maximum Negro population. Each county which has had a Negro population of at least one person per square mile at the census of 1880 or at any subsequent census is shaded according to the date of the census at which its maximum Negro population was attained.

the farms; perhaps wartime labor shortages in northern cities were pulling them off; in any event, three-fifths of the counties of South Carolina and Georgia, half in Arkansas and northern Florida, a third in Alabama, and a quarter in East Texas had more Negroes in 1910 or in 1920 than they have ever had before or since. North Carolina counties held their own, but throughout the rest of the Cotton South, from South Carolina to Oklahoma and Texas, the Negro population of many counties reached its peak at this period.

The years 1930 and 1940 were the heyday of the Negro population in the western parts of the South, with heavy concentrations in central Oklahoma, on the sandy lands of Texas–Arkansas–Louisiana and of southern Mississippi, and on the alluvial lands along the Mississippi River. In this same period the Negro population curve reached its apex in coal-mining areas of Pennsylvania and West Virginia, in Piedmont and mountain areas of western North Carolina, and in parts of the Georgia–Florida flatwoods.

At this point attention needs to be called to the relationship between peak Negro population and the regional trends which have already been discussed. The sharp drop in the percentage of the Negro population in the South Atlantic states after 1920 corresponds with the fact that so many South Carolina and Georgia counties had their peak Negro population in 1910 or in 1920 (cf. Figs. 1 and 9). The steady decline in the East South Central region's share between 1920 and 1950 is mirrored in the counties of Alabama, which

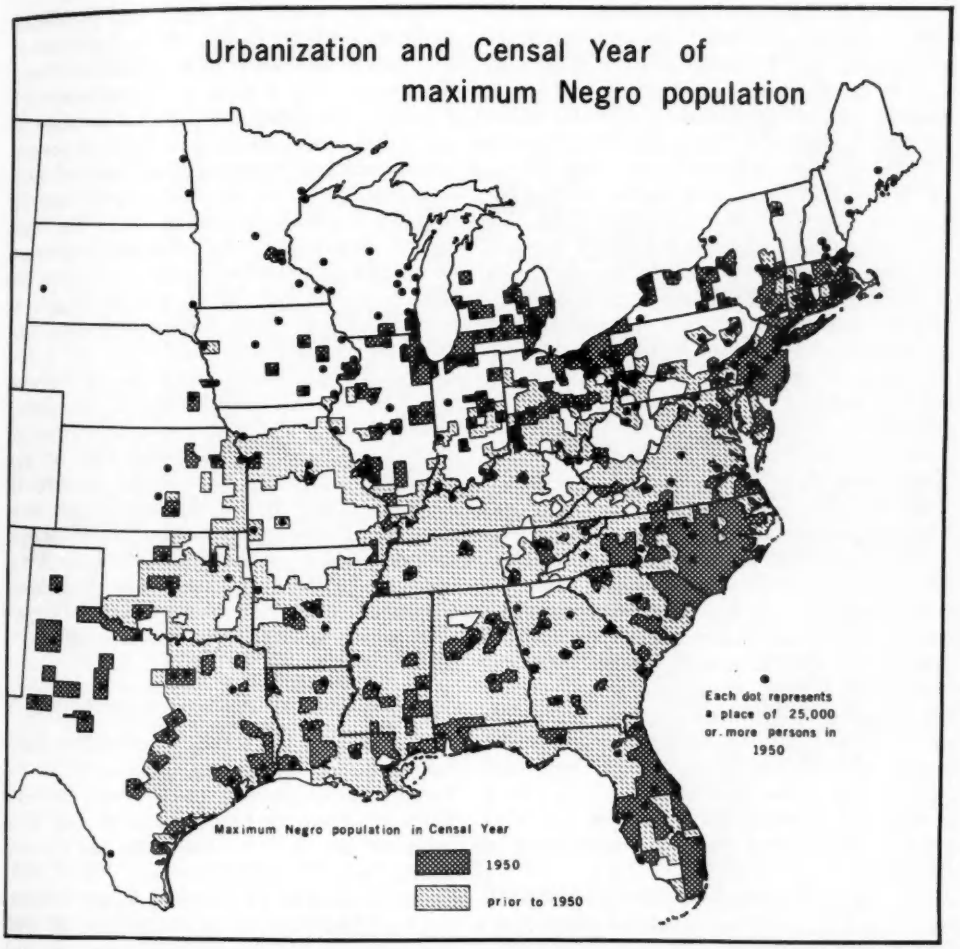

FIG. 10. Relationship between urbanization and census year of maximum Negro population. The darker shading shows those counties which had their maximum Negro population in 1950, and the black dots represent cities of 25,000 or more in 1950; their relationship is striking. The more lightly shaded counties had fewer Negroes in 1950 than they had at some previous time.

had their peak years in 1920 or 1930, and in the counties of Mississippi, which had theirs in 1930 or 1940. The sharp decline in the West South Central region's share after 1940 is closely related to the fact that so many counties in Texas, Louisiana, and Arkansas had their peak Negro population in 1930 or 1940.

The counties whose Negro population was at its zenith in 1950 are rather less concentrated than those counties whose Negro population crested earlier. True enough, there are some quite obvious concentrations of counties with a 1950 peak—in the tier of states from Illinois to the Atlantic Seaboard, in eastern North Carolina, and in peninsular Florida—but a large number of such counties are scattered through the South.

Outside of North Carolina and Florida the counties which had their maximum Negro population in 1950 are urban, for the most part, and their distribution is closely related to the distribution of major urban centers (Fig. 10). Some city counties—especially north and west of Chicago—lacked the one

Negro per square mile necessary for inclusion in this investigation, and some city counties in the South had fewer Negroes in 1950 than in some previous census year. By and large, however, one may conclude that those counties which contain a major city also attained their major Negro population in 1950.

This conclusion, of course, led to the refined grouping of areas used above in discussing regional trends in the Negro population, because in the South the trends of the metropolitan and nonmetropolitan Negro populations quite obviously are diverging (Fig. 2). Furthermore, the trend of the Negro population in Florida and in North Carolina differs from other parts of the South.

A number of factors presumably contribute to the fact that such a large part of peninsular Florida recorded its maximum Negro population in 1950. The absolute increase in the Negro population between 1940 and 1950 was not large, and the Negro density in Florida is still sparse (Fig. 3). Counties are comparatively large, and many have urban centers which have retained the natural increase of their Negro population and even attracted immigrants. These urban centers have rather large numbers of retired persons, representing an unusually good opportunity for Negro employment in personal services, and presumably the influx of people from the North has created a social climate rather more acceptable to Negroes than in other parts of the South.

The concentration of counties with a 1950 peak Negro population in eastern North Carolina is more puzzling, and thus far no completely satisfactory explanation for it has been discovered. It has been suggested that a more enlightened political climate might have played a role in providing more acceptable conditions for Negro life, but this concentration is in the politically more conservative part of the state; furthermore, it includes eight counties in South Carolina, a state not especially renowned for the excellence of its race relations. Later in this paper it will be suggested that the agricultural system and demographic history of the area might provide some explanation, but the unique character of the rural Negro population trend in eastern North Carolina unquestionably warrants further investigation.

To what extent has the Negro population declined since its peak year in those five of every six southern counties which had fewer Negroes in 1950 than in some previous year? Although the relationship is not as close as might have been suspected, there is general correspondence between the length of time since the peak was reached and the amount of subsequent decline (Fig. 11). The simplest rule of thumb, which has almost as many exceptions as instances, is that the decline has been approximately 10 percent per decade in those counties whose Negro population was at its maximum before 1950.

One is immediately tempted to wonder about the extent to which Negro depopulation has continued, and about where Negroes go when they leave. Our attention thus far has been focused on changes in the numbers of Negroes living in specific areas, with little mention of migration. Before we can discuss Negro migration in the United State, however, we need to consider the various techniques by which it can be measured, the types of data which are available, and the pitfalls to heed.

TECHNIQUES OF MEASURING MIGRATION

Four more or less standard techniques might be used for measuring migration in the United States during the decade 1940–50. Each of these techniques makes use of a different set of data, and each has its own strong points and weaknesses. These techniques consist in an analysis of four criteria:

(1) *Mobility*: A representative 20 percent sample of persons one year old and over at the time of the 1950 census were asked their place of residence one year previously. On the basis of their responses, data have been published on the numbers and some selected characteristics of nonwhite migrants for State Economic Areas.[10] It can be argued, however, that the State Economic Area is not an especially satisfactory unit of area for geographic purposes. Furthermore, these data pertain only to a single year, and unfortunately it was a year in which mobility appears to have been relatively low for the postwar years because

[10] *U. S. Census of Population: 1950.* Vol. IV, *Special Reports*, Part 4, Chapter B, "Population Mobility—States and State Economic Areas" (Washington: Government Printing Office, 1956).

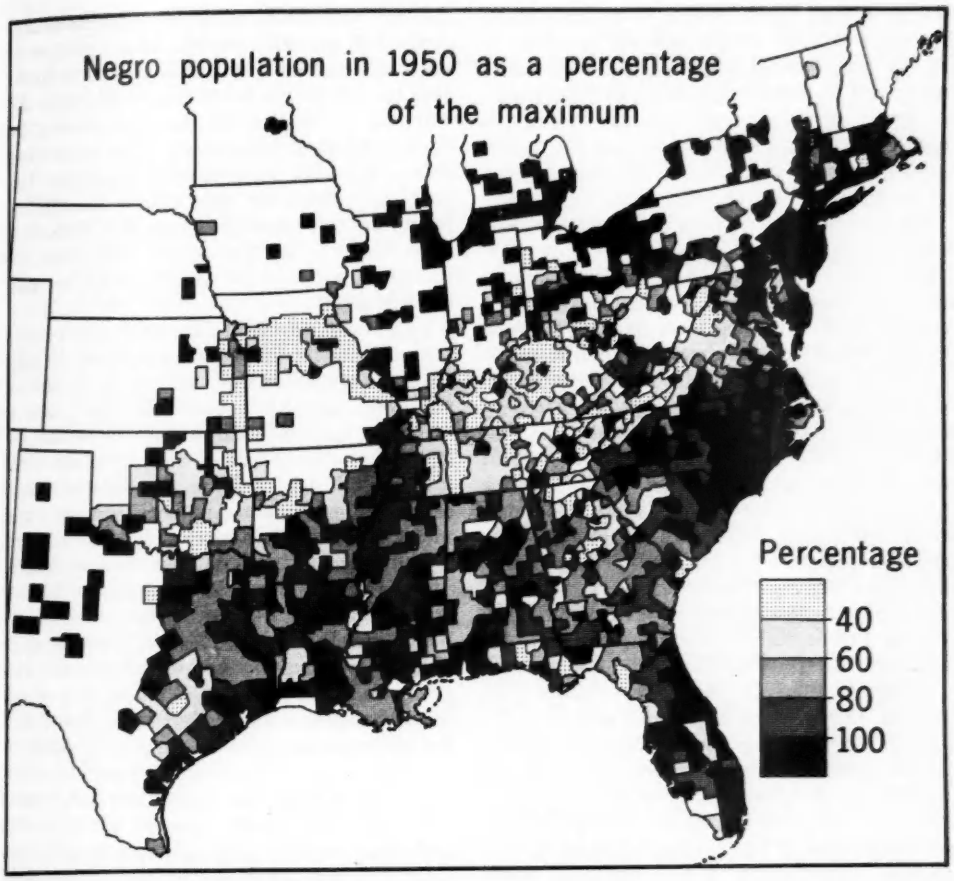

FIG. 11. Negro population in 1950 as a percentage of the maximum Negro population attained in each county which had at least one Negro per square mile at the time of maximum population.

of the mild economic recession of 1949 and 1950. A final minor objection is the difficulty of distinguishing the specialized migration of college students. For these reasons it was concluded that this measure of migration would contribute little or nothing to the present study, and consequently it has not been used.

(2) *Census Survival Ratio*: The prime exemplar of the census survival ratio as a measure of migration is the monumental work of Everett S. Lee in estimating migration data for each state for each decade since 1870.[11] A survival ratio for each age-sex group is calculated by dividing the number of persons in the age-sex group by the number of persons in the age-sex group ten years younger at the previous decennial census. This ratio is calculated for the entire population of the nation; if it is assumed that age-specific mortality rates are uniform throughout the nation, then this ratio represents the intercensal change which would occur in the age-sex group within each unit of area if there were no migration. The actual population of the younger age-sex

[11] Everett S. Lee, "Migration Estimates," pp. 7–361 of Everett S. Lee, Ann Ratner Miller, Carol P. Brainerd, and Richard A. Easterlin, *Population Redistribution and Economic Growth: United States, 1870–1950*. Vol. I, *Methodological Considerations and Reference Tables* (Philadelphia: American Philosophical Society, 1957).

group at the earlier census is multiplied by the survival ratio to provide an estimate of the number of persons in the group who would have lived to be enumerated in the older age-sex group at the succeeding census. The difference between this estimate and the population actually enumerated in the age-sex group is attributed to migration.

For instance, the number of nonwhite males aged 20–24 in the United States in 1950 (603,511) is divided by the number of nonwhite males aged 10–14 in the United States in 1940 (693,322) to give a survival ratio of 0.8703. When the number of nonwhite males age 10–14 in Sunflower County, Mississippi, in 1940 (2,302) is multiplied by the survival ratio of 0.8703, one obtains an estimate that 2,003 nonwhite males in this group should have lived to be enumerated in the age-sex group aged 20–24 in 1950. In 1950, 1,539 nonwhite males aged 20–24 were actually enumerated in Sunflower County, and it is assumed that the difference represents a loss of 464 persons from this group by migration. The process is repeated for each age-sex group to determine the total gain or loss by migration.

Although they are obligatory under this method, any geographer would wince at the assumptions (1) that there are no areal variations in the age-sex pyramids of states and counties in the United States, and (2) that there are no areal variations in age-specific mortality rates of states and counties in this country. Lee himself points out that "there are considerable differences in relative survival ratios among the states,"[12] and it is only logical to assume that there are even greater differences between counties. There is the further objection that this technique yields estimates only for persons ten years old or older, and further complicated calculations are necessary to estimate the migration of persons born during the intercensal period.

For these reasons the census survival ratio technique of measuring migration has not been used in the present study, despite its very great value for certain types of investigation.[13] If adequate age data are available the survival ratios are easily computed and applied to provide a wealth of information on the age-sex composition of migrants. It should also be noted that estimates obtained by the survival-ratio technique are not affected by the migration of previous decades, as are those obtained by the state-of-birth technique. Lee concludes, however, that correspondence between data obtained by these two methods is remarkably good for major migrations, although there may be discrepancies on small movements.[14]

(3) *State of birth*: In the census of 1950 a representative 20 percent sample of the population were asked their state of birth, and the resulting data have been published with a complete cross-tabulation of state of birth by state of residence.[15] For any state, therefore, it is possible to determine the states of which all of its residents are natives, and the states in which all of its natives are resident.

Unfortunately, albeit for understandable reasons of economy, data on state of birth—and also on vital statistics, which are discussed below—are published only for nonwhite population, without separate tabulation for Negroes, Indians, Japanese, Chinese, and others. The Taeubers suggest, however, that "since the Negroes are such a large portion (95.5%) of all nonwhites, the trends in numbers, structure, and distribution in the nonwhite population are essentially those of the Negro,"[16] and demographers generally appear to find no fault with this assumption. It is not precisely correct, however, to equate the nonwhite and Negro populations, especially at the county level,[17] and in this paper the terms "Negro" and "nonwhite" are specifically differentiated. Data for the Negro population are used whenever possible, but when data for Negroes alone are not available in published form, data for the nonwhite population are used, and the population is referred to as "nonwhite" rather than as "Negro."

[12] *Ibid.*, p. 34.

[13] For instance, see Gladys K. Bowles, *Farm Population: Net Migration from the Rural-Farm Population, 1940–50*, U. S. Department of Agriculture Statistical Bulletin No. 176 (Washington: Government Printing Office, 1956).

[14] Lee, *op. cit.*, p. 95.

[15] *U. S. Census of Population: 1950.* Vol. IV, *Special Reports*, Part 4, Chapter A, "State of Birth" (Washington: Government Printing Office, 1953).

[16] Conrad Taeuber and Irene B. Taeuber, *The Changing Population of the United States* (New York: John Wiley & Sons, 1958), p. 71.

[17] Wesley C. Calef and Howard J. Nelson, "Distribution of Negro Population in the United States," *Geographical Review*, Vol. 46 (January 1956), pp. 82–97.

Data on state of birth must be used with a certain degree of caution, because they indicate only the net resultant of migration during the widely variant lifetimes of the persons enumerated, and give no information in intermediate or intra-state moves. They also tend to be heavily weighted toward adjacent states because of the ease with which persons move their residences across state lines, especially when the state line transects a metropolitan area.

State of birth data have been published for every census from 1850, however, and it is possible to circumvent some of the difficulties described above by computing intercensal change. For instance, if the 34,653 nonwhite natives of Georgia residing in New York in 1940 are subtracted from the corresponding 62,605 in 1950, it would appear that 27,952 nonwhite natives of Georgia had moved to New York in the decade of 1940–50. A problem of indeterminate proportions is created, however, by the intercensal deaths of migrants from previous decades. In 1940, for example, Arkansas residents included 2,166 nonwhite natives of South Carolina, whereas the number had declined to 1,315 in 1950. The loss of 851 persons may be attributable either to back-migration or to deaths of earlier migrants.

Nevertheless, despite the defects which require that they be used and interpreted with the greatest caution, state of birth data are indispensable to any study of migration, for they are the only available source of information on the direction of movement, and even of the very existence of migration streams. Furthermore, the user can take considerable comfort in Lee's conclusion, cited above, that data obtained by the census survival ratio and the state of birth computations are reasonably comparable insofar as major movements are concerned.

(4) *Natural increase*: The number of people in any given area can be changed only by births, deaths, and migration. The technique of using natural increase to measure migration assumes that any intercensal population increase greater than the natural increase —the surplus of births over deaths—must result from in-migration, and that a population increase less than the natural increase must result from out-migration.

TABLE 4.—NONWHITE NATURAL INCREASE IN TWO SELECTED COUNTIES, 1940–49[1]

Year	Marshall County, Miss.		Peach County, Ga.	
	Deaths	Births	Deaths	Births
1940	201	605	85	165
1941	165	572	83	166
1942	193	654	89	187
1943	158	626	83	172
1944	155	594	88	180
1945	167	588	81	174
1946	160	616	86	154
1947	165	710	59	171
1948	146	714	67	219
1949	145	734	75	211
Total	1,655	6,413	796	1,799
Natural increase	4,758		1,003	

[1] Source of data: *Vital Statistics of the United States*, Births and Deaths by Place of Residence, for appropriate years.

The amount of natural increase is determined easily enough from data contained in the annual volumes of *Vital Statistics of the United States*, which give the number of births and deaths each year, by place of residence, for every county in the United States and for every city with a population of at least 10,000 persons at the preceding census. In the years 1940–49, for example, Marshall County, Mississippi, had 6,413 nonwhite births and 1,655 nonwhite deaths for a natural increase of 4,758 nonwhite persons; Peach County, Georgia, had 1,799 nonwhite births and 796 nonwhite deaths for a natural increase of 1,003 nonwhite persons (Table 4). Unhappily, the vital statistics data, like the state of birth data, make no distinction between Negroes and other nonwhite persons, and even separate nonwhite data are published only for those counties and places in which the nonwhite population formed at least 10 percent of the total population or numbered 10,000 or more persons at the last census. Where published, however, they are the best available source for measuring migration at the county level.

The number of migrants from any given county is determined by subtracting the natural increase from the population increase; it is necessary to perform this operation algebraically, because either quantity may actually represent a decrease rather than an increase, and hence must be treated as a negative quantity. The result indicates in-migration if positive, out-migration if negative. The population increase must be corrected, where appropri-

TABLE 5.—NONWHITE MIGRATION FROM TWO SELECTED COUNTIES, 1940–50

	Marshall Co., Miss.	Peach Co., Ga.
1940 population	17,966	6,366
Number of students in 1940[1]	118	225
Total in 1940	18,084	6,591
1950 population	17,730	7,173
Population increase	–354	582
Less natural increase	–4,758	–1,003
Number of migrants	–5,112	–421
Migration rate	–28.5%	–6.6%

[1] Data on resident college enrollment during the regular session, 1939–40 in Rust College (Holly Springs, Miss.) and Fort Valley State College (Fort Valley, Ga.) from Table 18, "Faculty, Students, and Graduates, 1939–40," in U. S. Office of Education, *Biennial Surveys of Education in the United States, 1938–40 and 1940–42*, Vol. II, Chap. IV, "Statistics of Higher Education, 1939–40 and 1941–42."

ate, for the change in place of enumeration of college students, who in 1950 were enumerated in the college community rather than in the community of parental home, as in 1940. As there is no possibility of "restoring" college students to the home community in 1950, this correction is best made by adding the resident college enrollment during the regular session, 1939–40, to the 1940 population of the college community.

In 1940, for instance, Marshall County, Mississippi, had a nonwhite population of 17,966 persons, plus 118 students in Rust College at Holly Springs, for a total population of 18,084 (Table 5). The nonwhite population in 1950 was only 17,730 persons, a loss of 354 persons, whereas the natural increase, as we have seen in Table 3, was 4,758 persons. Algebraic subtraction of the natural increase shows that there were 5,112 nonwhite migrants from Marshall County in the decade 1940–50. Peach County, Georgia, illustrates the calculation of migration when the population has increased. The migration rate is calculated by dividing the number of migrants by the 1940 population, and is given the same sign as the number of migrants; in-migration is indicated by a plus sign, out-migration by a minus.

NONWHITE INTERSTATE MIGRATION, 1940–50

Both state of birth and natural-increase measurements must be used to develop a clear picture of nonwhite migration patterns in the decade 1940–50. State of birth data reveal the dominant patterns of interstate movement, but give no indication of source or magnet areas within states. The magnitude of migration in each county can be computed from the natural increase, but this gives no indication of the origin or destination of migrants. Comparison of the patterns revealed by the two sets of data, however, appear to justify conclusions which are not warranted on the basis of either set of data alone.

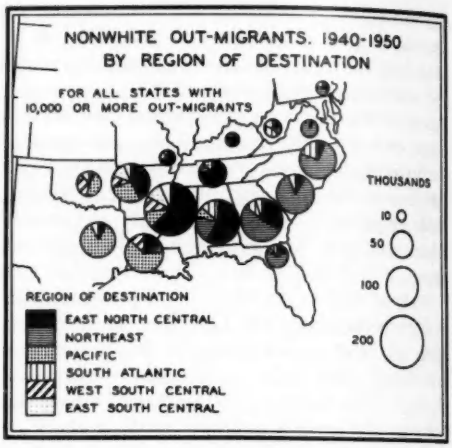

FIG. 12. Region of destination of nonwhite migrants, 1940–50, calculated from intercensal change in state of birth data. Regions are identical with the geographic divisions used by the Bureau of the Census, except that the Northeast includes both the New England and the Middle Atlantic divisions.

As measured by the state of birth data, Mississippi was the leading producer of nonwhite migrants in the decade 1940–50 but was not far ahead of the other seven states from North Carolina to Florida (Fig. 12). Smaller numbers were produced by Oklahoma, Tennessee, and Florida, and even fewer by the four border states from Virginia to Missouri. Pennsylvania was the lone state outside the South to produce more than 10,000 out-migrants.

Interstate nonwhite migration is highly selective regionally; that is, a large percentage of the migrants from each region select the same region of destination. In each of the South Atlantic states except Georgia, for instance, more than three-quarters of the nonwhite migrants went to the Northeast, which also attracted just over half of the nonwhite migrants from Georgia. The Northeast attracted less than a quarter of the nonwhite migrants from Alabama, however, and had

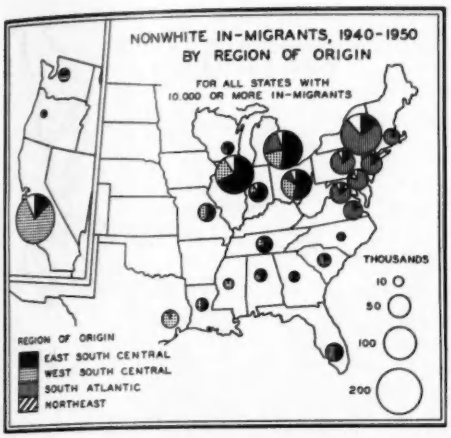

FIG. 13. Region of origin of nonwhite migrants, 1940–50, calculated from intercensal change in state of birth data. Regions are identical with the geographic divisions used by the Bureau of the Census, except that the New England and the Middle Atlantic divisions are combined as the Northeast.

virtually no attraction for migrants from other states.[18]

In similar fashion, the largest proportion of nonwhite migrants from the East South Central states went due northward. The majority of nonwhite migrants from Mississippi, Alabama, Tennessee, and Kentucky, as well as almost half of those from Arkansas, were attracted into the East North Central states. The pull of the Pacific states was felt slightly in Mississippi, somewhat more strongly in Arkansas and Oklahoma, and most strongly of all in Louisiana and Texas; to a lesser degree the westward surge from the West South Central states is indicated by the extent of intra-regional migration, which is directed almost entirely into Texas.

The other side of the coin reveals the same high degree of regional selectivity in nonwhite migration; just as each source region has a dominating region of destination, so each migration magnet region pulls primarily from a single region of origin (Fig. 13). Three-fourths of the nonwhite migrants to the Pacific states hailed from the four West South Central states. Illinois and Indiana received almost three-fourths, and Wisconsin, Michigan, Ohio, and Missouri rather more than half their nonwhite migrants from the four East South Central states. And three of every four migrants to Megalopolis had come up the Atlantic Seaboard from the South Atlantic states.

These data indicate that there were three great streams of nonwhite migration in the United States in the decade 1940–50. One moved westward from the trans-Mississippi South toward the Pacific Coast. A second flowed northward from the middle South into the Middle West. The third moved up the Atlantic Seaboard from the South Atlantic states into the Northeast. The existence of these three streams reinforces our earlier conclusion about reciprocal trends in the Negro population of pairs of regions, one in and one outside the South (Fig. 1). This reciprocal relationship quite obviously is based on the flow of migrants, and the length of time over which these trends have existed gives some indication also that the streams of migration follow relatively old routes; it has even been pointed out that the streams fairly closely follow the old route of the Underground Railway!

If we wish to trace the origin and destination of nonwhite migration streams with greater geographic precision, on a county rather than a state basis, we must turn from state of birth data to natural increase data. In varying degree, nonwhite out-migration characterized the large majority of counties for which data could be computed in the decade 1940–50 (Fig. 14). The largest number of migrants came from the counties with the densest rural Negro population. The leading migrant producing area was the Delta country of Mississippi, with the Black Belt fairly close behind. Large numbers of migrants also came from the sandy lands of Louisiana and Texas, and the Inner Coastal Plain and Piedmont of Georgia and South Carolina.

At least three areas of apparently heavy out-migration—Iredell County, North Carolina, Jefferson County, Alabama, and East Baton Rouge Parish, Louisiana—seem to be simply a product of changes in city bounda-

[18] West Virginia has highly complicated patterns of nonwhite interregional migration primarily because the state is contiguous with four geographic divisions, and a considerable part of the nonwhite migration from the state may well consist merely of short shifts of residence across nearby state lines. To some extent this is also true of Arkansas.

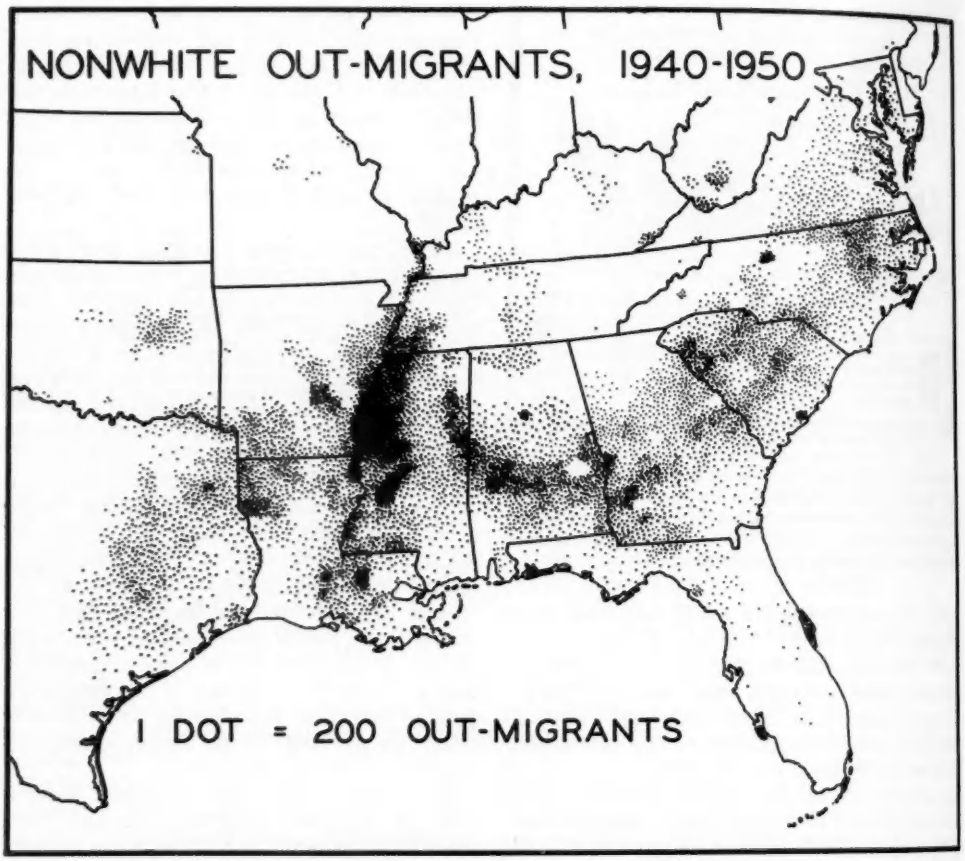

FIG. 14. Nonwhite out-migrants, 1940–50, as calculated from natural increase.

ries.[19] On the other hand, nonwhite overspill from cities or migration into cities of less than 10,000 persons—for which data are not available—appears to account for some counties of anomalously light out-migration, such as Macon County in Alabama or Dougherty, Bibb, Baldwin, and Richmond counties in Georgia.

There is relatively close areal relationship between those areas with large numbers of out-migrants and those areas with the heaviest rates of out-migration, although the rates in sparsely settled eastern Texas are higher than might have been suspected from the total number of migrants (Fig. 15). A large number of counties lost more than one-third of their nonwhite population by migration between 1940 and 1950, and the majority of counties from South Carolina to eastern Texas lost more than a quarter of their nonwhite population. The impressive implications of this figure, when it is remembered that the majority of migrants are in the younger age groups, are best realized by consideration of

[19] It is impossible to estimate compensating corrections for changes in city boundaries because population and vital statistics data are not available for the annexed area *alone*. Thus one cannot compute the decennial population change or the amount of natural increase within either the old or the new boundaries. The simple and admittedly unsatisfactory technique used here is utilization of data actually reported for both population and vital statistics. This has the effect of treating the entire 1940 population of the annexed area as migrants from the county to the city (which, in a sense, perhaps they were), thus producing high out-migration rates in the county and high in-migration rates in the city.

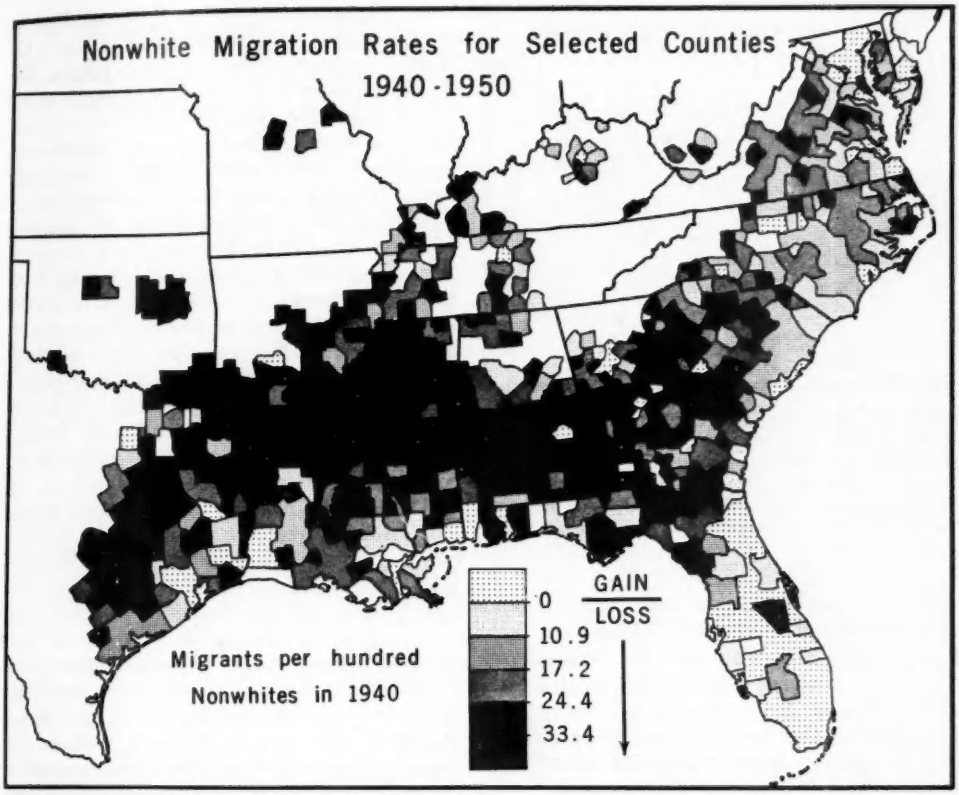

FIG. 15. The nonwhite migration rate for counties (excluding the population of cities of 10,000 or more persons) in which the nonwhite population in 1940 exceeded 10,000 persons or 10 percent of the total population. The migration rate is the number of migrants (calculated from natural increase) in the decade 1940–50 expressed as a percentage of the 1940 population.

counties farther north which had much lower rates of out-migration in the decade 1940–50.

In the rural areas of ten Kentucky Bluegrass counties, for instance, there were 24,490 Negroes in 1940 and only 20,736 in 1950, a loss of 3,724 persons. More than a fifth of the loss, however, can be attributed to the fact that these counties had 796 *more nonwhite deaths than births*. The explanation lies in the age structure which has been produced in these counties by long-continued out-migration. The migrants are most commonly young people, in the reproductive ages, and their departure by removing part of the reproductive potential of the county reduces the number of births. The number of births is reduced still farther as the remaining population ages and passes the reproductive years. In 1950, for example, 34 percent of the Negroes of the rural Bluegrass were aged 45 or older, as compared with 22 percent of the total Negro population of the nation. The migration rate from the aging and dying Negro population of the rural Bluegrass was low because, quite literally, there was no one left to migrate! The same is true for other counties along the northern fringes of the South, especially in Virginia. And if the 1940–50 migration rates are maintained, it is reasonable to expect that similar demographic conditions will characterize much of the rural South within a generation or so.

Paradoxically, the low migration rates of the eastern Carolinas appear to be attributable to a youthful population which has not been artificially aged by migration. For some reason (perhaps related to the difficulties in-

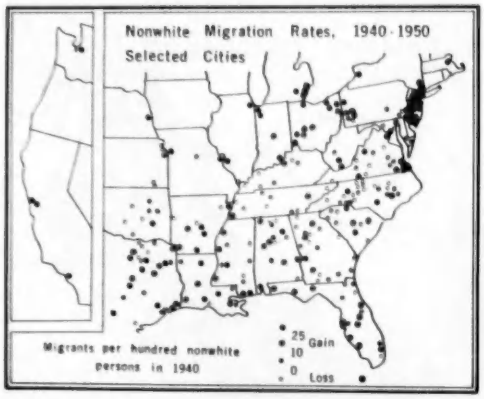

FIG. 16. The nonwhite migration rate for cities of 10,000 or more persons in 1940 in which the nonwhite population exceeded 10,000 persons or 10 percent of the total population. The migration rate is the number of migrants (calculated from natural increase) in the decade 1940–50 expressed as a percentage of the 1940 population.

volved in mechanizing various cultivational and harvesting operations required by such labor-hungry crops as peanuts, cotton, and flue-cured tobacco) the counties of this area appear not to have experienced heavy outmigration in the past, and the population is still young. In twenty counties selected at random from this area, only 16 percent of the Negro population was aged 45 or older, as compared with 22 percent in the nation, and 34 percent in the Bluegrass. It would appear that a youthful Negro population with a high rate of reproduction accounts for the low migration rate, despite the fact that relatively large numbers of migrants have left the area. It is further suggested that the age structure of the population might be a clue to the problem of why this area should have attained its maximum population in 1950 (Fig. 9).

On the urban side, many southern cities had negative or only very low positive migration rates for the decade 1940–50 (Fig. 16). Nonwhite migration from urban areas was especially pronounced in the Border states and on the Piedmont, but every southern state had at least one city whose nonwhite population declined as a result of migration. Furthermore, relatively few southern cities had high rates of in-migration, although there were exceptions in the Norfolk area, along the Gulf Coast, and in the western South. As a general rule, it appears safe to conclude that cities in the South had surprisingly little attraction for Negro migrants, whereas cities outside the South typically had high rates of in-migration.

Unfortunately, these data give only the net resultant of migration, and it is therefore impossible to tell whether cities in the South act as "staging points" for Negro migrants. It would be interesting to know, for instance, whether the Negro migrant from the rural South goes straight from the cotton fields to the asphalt jungle of the metropolis, or whether he first spends an acclimatization period in a smaller city. It is possible that a southern city could experience considerable in-migration which would not appear here if it had been balanced by migration "up the ladder" to a larger town on the part of natives or in-migrants of an earlier decade.

There is no question that the major metropolitan areas were the major magnets for Negro migrants in the decade 1940–50 (Fig. 17). The Houston area, greatest magnet in the South, attracted less than fifty thousand nonwhite persons during the entire decade, greater Norfolk attracted only thirty-seven thousand, Memphis, Atlanta, and New Orleans only twelve thousand each, and Birmingham only eight thousand. These six metropolitan areas, combined, attracted fewer nonwhite persons than did metropolitan Detroit alone, and only half as many as metropolitan New York. Metropolitan Los Angeles attracted almost as many nonwhite persons during the decade as the three most attractive metropolitan areas in the South.

The vast bulk of Negro migrants, in short, are moving to cities outside the South. South of a line from Norfolk through Cincinnati and St. Louis to Los Angeles only a very few cities attracted as many as a thousand nonwhite migrants a year over the decade. But Baltimore and St. Louis averaged four thousand a year, Washington six thousand, San Francisco eight thousand, Los Angeles nine thousand, Philadelphia ten thousand, Detroit thirteen thousand, and Chicago twenty thousand a year. And metropolitan New York attracted an average of two thousand nonwhite migrants each *month* for the entire decade.

Within the South only the towns and cities are attracting Negro migrants, and the Negro population increase of the South is concen-

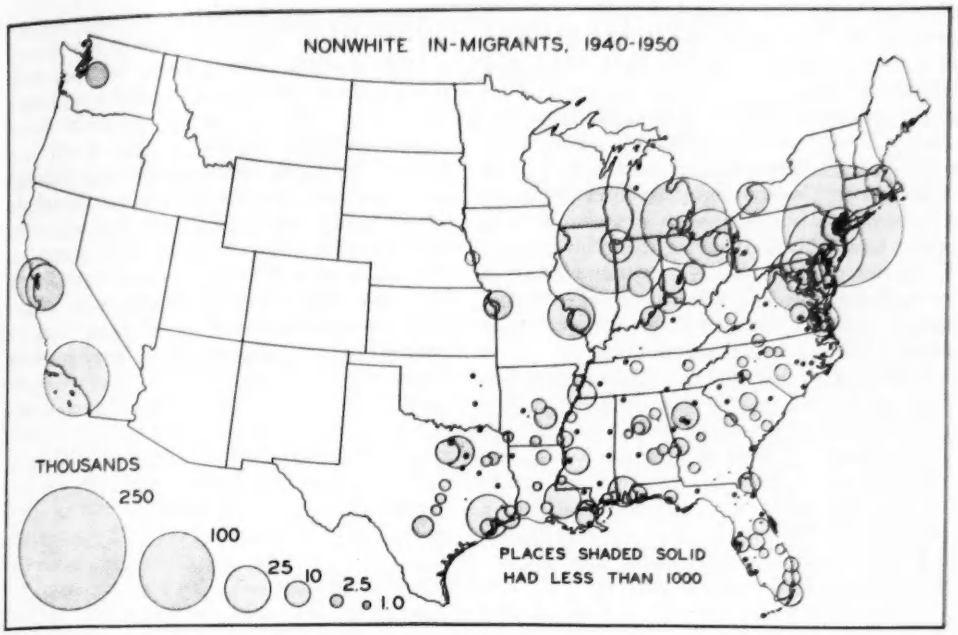

FIG. 17. Nonwhite in-migrants, 1940–50, as calculated from natural increase. Circles are proportional to the number of migrants.

trated almost entirely in the cities. Virtually all nonmetropolitan counties in the South had a smaller Negro population than at some previous census, whereas the majority of the metropolitan counties had more Negroes than they ever had before (Fig. 10). As noted earlier, these divergent trends within the South suggested the desirability of refining the areas originally used in discussing regional trends in the Negro population (Fig. 2).

CONCLUSION

The American Negro is becoming increasingly urbanized, and largely as a result of migration from the rural South to metropolitan areas outside the South. In light of the information here presented, the three major streams of Negro migration in the United States can be defined more precisely. Natural increase data indicate that the great majority of Negro migrants from the South Atlantic states come from the Inner Coastal Plain and the Piedmont of Georgia, the Carolinas, and Virginia; state of birth data show that the vast majority of migrants from these states move to the Northeast; and natural increase data indicate that migrants to the Northeast settle almost entirely in the metropolitan areas of Megalopolis.

In the same fashion, we may conclude that the second major stream consists of migrants from the Delta, the Black Belt, and virtually the entire state of Mississippi who are moving toward Chicago, Detroit, and the other urban centers from Cleveland to St. Louis. This stream, like the first, is fed partially from the Georgia-Alabama Coastal Plain, which also appears to send migrants to peninsular Florida. The third stream of Negro migration originates in the sandy lands of southern Arkansas, northern Louisiana, and eastern Texas, and flows westward toward Los Angeles, San Francisco, and Seattle; some migrants from the Delta also appear to join this stream.

Examination of Negro population trends by regions shows a reciprocity between regions which would seem to indicate that these streams of migration have existed for at least half a century, although their volume was not so great in the earlier years. Migration has nonetheless decimated the Negro population

of many areas, as is revealed by the study of peak years. First, Negroes left the hills, which had reached their peak by 1900; then they left the South Atlantic states, where 1910–20 peaks are most common; next came heavy migration from the central South, where most counties have peaks between 1910 and 1940; more recently heavy migration from the trans-Mississippi South has been associated with peaks in 1930 and in 1940. But the cities—the major magnets for Negro migrants—had more Negroes in 1950 than they had ever had before, and are increasing their share of the nation's increasing Negro population.

Urbanization for the American Negro has come more belatedly than it came for his white neighbor, but now that it has started it is proceeding with a rush. Negroes have almost disappeared in some rural areas where once they were numerous. Virtually every nonmetropolitan county in the South had fewer Negroes in 1950 than in some previous year, whereas metropolitan areas throughout the nation had their maximum Negro population in 1950. But Negro migrants are attracted mainly to cities outside the South. In short, the American Negro, who was a rural Southerner two generations ago, is rapidly becoming an urban Northerner or Westerner.

THE LABRADOR FLOATER CODFISHERY[1]

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THE Labrador floater fishery, one of Newfoundland's best-known fisheries, remained in operation for almost two centuries and reached its maximum development in the last quarter of the nineteenth century and the first decade of the present century. The fishery made a significant contribution to the economic growth of Newfoundland, accounting for one-quarter to one-half of the province's entire production of salt codfish. Each year hundreds of schooners and thousands of men sailed "down north" for the sheltered harbors and coves of the Labrador coast to trap the "fish" as cod is called by the Newfoundland fishermen. At the close of the 1954 season, this fishery ceased to operate.

A number of factors associated with its internal and economic structure contributed substantially to the abandonment of the floater fishery. These factors, together with competitive marketing, could not be accommodated within the framework upon which the industry had developed. This study is concerned with these factors and their impact upon various aspects of the industry. The objective, therefore, is to show that the industry was inherently unstable and that it could not survive in the modern competitive world. In this connection, the development of the fishery, its internal and economic structure as viewed against the fishery's historical and geographical background are traced from its inception to its termination.

This study shows that the industry was unstable originally when the fishery was based at English ports and later when it was based at Newfoundland ports adjacent to the Labrador fishing grounds. Methods of production, organization, and distribution altered but little in the course of the industry's history. These practices were honored by tradition and, having proved apparently sound, prevented introduction of more efficient methods. The major result was to produce submarginal yields. An analysis of productivity demonstrates this fact, and a comparison of operating costs to net returns shows that the industry was operating on an unprofitable basis. Against low productivity and unprofitable operation, no industry can hope to survive. This study also shows that the unstable domestic economic setting and the selective and restrictive nature of foreign markets imposed additional barriers for the industry. Such conditions were adverse to the successful production of the Labrador floater product. Having failed to accommodate itself to changing market requirements, the industry was doomed.

THE DEVELOPMENT OF THE SHIP FISHERY

English Ship Fishery

During his term of office as governor of Newfoundland, 1764–69, Sir Hugh Palliser encouraged the British West Country fish merchants to establish a fishery on the Strait of Belle Isle. Previous to this, from 1702 to 1763, there were no British fishing vessels on the Labrador coast, only French fishermen. In 1765, Palliser reported that of the 117 sloops and schooners on the Strait of Belle Isle there was not one "Olde England ship." He thoroughly discouraged colonization, forbidding the inhabitants of Newfoundland to go to the coast of Labrador or to winter on that coast.[2] He severely curbed the activities of the French fishermen and established the West Country "fishing admirals" on the Labrador coast. He considered Labrador and Newfoundland essentially a fishing station to

[1] Published by permission of the Director, Geographical Branch, Department of Mines and Technical Surveys, Ottawa, Canada. Maps and drawings were prepared in the Geographical Branch drafting office. The helpful assistance of B. V. Gutsell, technical editor of the Geographical Branch, in reading through the manuscript is acknowledged.

[2] Great Britain, Privy Council, Judicial Committee, *In the Matter of the Boundary between the Dominion of Canada and the Colony of Newfoundland in the Labrador Peninsula between the Dominion of Canada of the One Part and the Colony of Newfoundland of the Other Part. Joint Appendix* (12 vols.; London: William Clowes and Sons, Limited, 1926), Vol. 3, pp. 943–44. (Hereafter cited as *Labrador Documents.*)

be exploited by the fish merchants and a training school for the Royal Navy. This policy resulted in such a marked increase in the number of English vessels that by 1775 a hundred were engaged in the Labrador fishery. This period marked the beginning of the Labrador floater fishery.

During the long period of the Napoleonic wars the fishing fleets from England and France were severely handicapped by the constant demand of their governments for vessels. The French fishery ceased and the English ship fishery, based at English ports, rapidly declined in numbers. Of the 276 English vessels in Newfoundland–Labrador coastal waters in 1792, 89 were fishing on the Labrador coast, while in 1817 at the end of hostilities the Labrador fishery had decreased to 48 vessels, and in 1823, to 15 vessels. Thus in 1824, the Governor, Sir Charles Hamilton of Newfoundland was able to state, "the English Ship Fishery has diminished to little more than a name."[3]

This failure was due largely to historical trends. Newfoundland had now emerged as a distinct economic unit with a substantial and increasing resident population that had gradually established a shore or station fishery adjacent to the coastal fishing grounds. In the face of such natural advantages the West Country merchants were forced to give up the fostering of an industry based at English home ports. The fishery was gradually transferred to a fishery based at Newfoundland ports and became known as the Labrador floater fishery, operating principally from St. John's and from the outports of Conception Bay.

Labrador Floater Fishery

Newfoundland fishing vessels began sailing for the Labrador coast shortly after 1763; however, prior to 1809 their appearance on the coast was sporadic. The early impact of the Napoleonic wars brought about the institution of bounties on fish caught by British subjects and gave unofficial encouragement to Newfoundland-based vessels operating on the Labrador coast.

With the cessation of hostilities in 1818 and the subsequent return of the French fishermen to the French shore,[4] the Newfoundland fishermen who had fished there were expelled. Many of the latter turned to the Labrador floater fishery. In addition, the consistently poor yields on the Grand Banks turned many "bankers" to the Labrador fishery during the same period. Thus, by 1829 the floater fleet operating on the Labrador coast was reported to have increased sixfold. In 1825 the number of vessels annually outfitting for Labrador was reported to be between 60 and 70 from the Port of St. John's alone and nearly 200 from the Conception Bay ports.[5] By the middle of the nineteenth century approximately 700 vessels were engaged in the Labrador fishery, operating between Blanc Sablon on the Strait of Belle Isle and Cape Harrison, the northern boundary of the fishery for approximately a half century. By 1860 Newfoundland schooners had passed north of Hopedale. The growth of the fishery during the next 10 years may be attested by the fact that 6 vessels fished at Hopedale in 1863; 25 in 1866; 108 in 1868. In 1870 over 500 schooners passed north of this station and 400 passed north of Cape Mugford in 1875.[6] It was not until 1901 that the first Newfoundland fishing schooner reached Ramah in northern Labrador.

A marked expansion in the floater fishery took place from 1894 to 1908, the peak of the fishery, an expansion that was associated with general world-wide prosperity. During this period the number of vessels increased from 825 to 1,400, an increase of 70 percent. When, in 1907, 1,192 vessels were engaged in fishing, their total crews numbered 8,344 persons. The exact quantity of codfish caught by the floaters during any particular season is impos-

[3] *Labrador Documents, op. cit.*, Vol. 4, p. 1941. The *Labrador Documents* contain detailed accounts of the social, economic, administrative, political, and international aspects of the coast of Labrador as well as frequent accounts of its people and resources.

[4] French subjects, by previous treaties, were granted the privilege of catching and curing fish on certain parts of the coast of Newfoundland. Under the Treaty of Versailles of 1783 the limits of the area were altered so as to extend from Cape St. John northward around the Longe Range peninsula to Cape Ray on Cabot Strait. In 1904 France renounced her claim to this shore. This stretch of coast is referred to locally as the "French" or "Treaty" shore.

[5] *Labrador Documents, op. cit.*, Vol. 3, p. 1232.

[6] W. G. Gosling, *Labrador: Its Discovery, Exploration and Development* (Toronto: Musson Book Co., 1910), pp. 413, 422. This work contains detailed accounts of the various ship fisheries that operated in the past on the Labrador coast.

sible to find; however, in view of the size of the fleet the catch at this time must have reached one million quintals or hundredweights annually.

Associated with the marked expansion of the floater fishery at the end of the last century was the extensive use of the codtrap which was developed by a Bonne Esperance fisherman about 1870, and was particularly effective in exploiting the large shoals of cod that moved inshore. In the Labrador fishery the number of traps increased from 2,588 in 1891 to 6,530 in 1910, and about two-thirds of them were used by the floaters. The trap proved much more productive than the cod seine net which it replaced. Labrador heavy-salted codfish, the major production of the industry known as "Genuine Labrador Cure," was considered in Europe at one time as the best quality in heavy-salted fish. After World War I, the difficulty of marketing heavy-salted codfish in the principal or traditional markets of Spain, Portugal, Italy, and Greece became a serious problem. In fact, by 1920 the number of schooners engaged in the fishery was about one-half of 1910. These countries developed subsidized fishing fleets which, aided by exchange controls, state subsidies, and import quotas, restricted importations of Labrador codfish. In addition, Iceland and Norway were successfully meeting the balance of these market requirements for the heavy-salted fish. The loss of the traditional markets for the Labrador product was followed by a substantially reduced demand for it; the heavy-salted codfish became a residual product, resulting in low returns to the floater fishermen. Meanwhile, in Newfoundland, exporters, merchants, and fishermen were turning in increasing numbers to the production of various types of fresh fish for which the smaller and thinner Labrador cod is not generally suited; moreover, filleting could be carried out in the ports of southern Newfoundland, and this area, with its relatively concentrated population, was considerably nearer export markets. After World War II, strong competition from local Newfoundland industries offered more continuous employment and higher income than the floater fishery. As a result the number of vessels engaging in the fishery continued to decline from 65 in 1950 to 5 in 1954—the year that marks the end of the fishery.

Economic Foundation of the Floater Fishery

The extinction of an industry which less than 50 years ago sent 1,400 schooners to the Labrador coast seems phenomenal, but the causes of the decline were deep-rooted, and much of the responsibility lay with the traditional attitude of the industry. From its inception the fishery experienced years of scarcity of fish on the coast as well as years of abundance; after a period of lean years the fishery was prosecuted with profit more vigorously than before. To meet these constantly changing conditions it had developed a structure of labor organization, ownership, and production relationships that were peculiarly characteristic of the economic setting in which it flourished. The economic "truck" system of the eighteenth and nineteenth centuries and the "credit" system of the early twentieth century provided the economic base upon which the industry existed.[7]

From the beginning of the fishery to the middle of the nineteenth century, the floater fishery was organized on a feudal basis that was generally known as the "truck" system. The fish merchants owned the means of production and employed fishermen to catch the fish. In return for their labor, as money was not exchanged, the fisherman received sufficient goods to maintain himself and his family to the next season. In years when catches were poor, it was the practice for the merchant to provide the necessary relief to support his own fishermen. The fishermen were economically bound to the merchants in somewhat the same manner as serfs were bound to their feudal lords. It was in fact a lingering remnant of feudalism.

By mid-century these practices were gradually modified and the credit system emerged. As the population had steadily increased, the ability of the fish merchants to support the

[7] For detailed treatment of the economic problems associated with the Newfoundland fisheries, see D. W. Prowse, *History of Newfoundland* (2nd ed; London, 1896); Harold A. Innis, *The Cod Fisheries: The History of an International Economy* (Toronto: Ryerson Press, 1940); R. A. Mackay, ed. *Newfoundland: Economic, Diplomatic and Strategic Studies* (Toronto: Oxford University Press, 1946); and G. M. Gerhardsen, *Salted Cod and Related Species*, F.A.O. Fisheries Study No. 1 (Washington, D.C., 1949).

increasing population declined. The obligation of the merchants to support their fishermen during bad years was gradually transferred to the government at St. John's. As these fishermen lacked the financial resources to carry on the fisheries, the practice developed for the fisherman in the spring to secure, from one of the large outfitting merchants or from one of the large mercantile concerns in St. John's,[8] supplies of salt, gear, and provisions, on credit. Without such supplies, the fisherman would be unable to prosecute the fishery or maintain his family through the fishing season. At the conclusion of the operations, the fish were turned over to the merchant as a "set off" against his account. The practices of the credit system were somewhat similar to that developed in the southern United States under the sharecropping system.

In bad years, which included years of poor catches or when marketing proved difficult, the value of the fish was often not sufficient to pay for outfitting. The fishermen remained in debt and until the next fishing season lived on government relief. In favorable years when a balance of cash was available, the funds were left with the merchant and the fisherman received a voucher for goods which he drew on until the surplus was spent. In the following spring the fisherman again returned to the merchant to be outfitted for the fishery. Most fishermen preferred to finance their operation at the merchant's expense rather than risk their private funds, if any. This method of financing was accomplished through the various forms of crew-sharing. The universal practice was for the fisherman, whether he was in debt or not, to turn his fish over to the merchant who outfitted him, even though a higher price might be secured from an itinerant buyer. The advantage of a more favorable price was balanced by the probable difficulty of securing an outfit the next season, save at higher prices. These practices had become the accepted way on the part of fishermen and merchants alike in conducting the fishery.[9]

The system had a number of serious defects, apart from the tendency to maintain a debt burden. Financing by merchants could not be expected to develop a strong, independent fishery; and there were no private financial institutions in the outports interested in risking capital to underwrite individuals or groups of fishermen. There was also no incentive for the use of the fisherman's private funds when supplies for the fishery could be obtained on credit from the merchants. The fishermen generally regarded the merchants as exploiters, rather than as important links in the system of distribution. The merchants, in turn, usually regarded the fishermen with contempt rather than as the basic producers upon which the island's economy depended. Thus the fishery was carried on against a psychological background of continual friction and often of bitterness between producer and exporter.

Under the credit system a number of methods for grading fish developed. Prior to World War I the "correct" system of grading was practiced. Under this method the fisherman, after curing his fish, turned it over to the merchant. The fish was then culled or graded. Labrador cure was described as "heavy-salted, soft-cured, genuine Labrador codfish" and when culled according to quality was graded as Quality No. 1, Quality No. 2, and cull. As the culler was an employee of the merchant, the tendency was to short-grade the fisherman in favor of the merchant. Also, the merchant usually up-graded the fish for export.

On account of food shortages during World War I, the strong demand for fish resulted in higher prices. Short-grading increased, the culls and the size element were dropped in the grading, and fish were purchased in lots by the merchants on the basis of quantity. This became known as the "talqual" system of buying. As the primary emphasis was to produce fish in quantity, the good fisherman was penalized for producing a high-quality cure, and received no extra financial return for his

[8] With the development of regular coastal transportation, the outfitting trade at St. John's declined. The fishermen became dependent on the local merchants for goods and credit; the merchants in turn depended on the mercantile houses of St. John's for their supply of goods and credit.

[9] For the psychological aspects of the credit system, see *Annual Reports of the Newfoundland Department of Fisheries* (St. John's, 1894). The report of this year is also known as the *Nielsen Fisheries Report*. Since that time the credit system has continued without any important change.

effort.[10] This resulted in a rapid deterioration of cure, and a rapid increase in the production of inferior grades; the effect on exports, because of poor quality, was the loss of foreign markets. During the years 1930 to 1934 Labrador cure became difficult to market at a value to cover costs of production. In 1933, with no markets in sight, the Salt Codfish Exportation Board abolished the talqual system of grading and re-established the grading or culling system. The culler, however, still remained an employee of the merchant, even though he was government-licensed. Obviously the culler favored the merchant. This system of grading continued until World War II, when a stricter system of inspection and grading was established. In all of these systems of grading, inspection was directed toward the marketing phase of the industry. No practical system of inspection was introduced among the floaters on the fishing grounds.

The credit system might have disappeared in the normal course of economic development had Newfoundland's politics been supported by public confidence.[11] Until 1890, the fisheries were conducted without any government administration; a Fisheries Commission was then established and it appeared that Newfoundland was following the normal trend toward modernization. From 1900 to 1933 politics intervened and the success of any attempt to modernize the fisheries waned with the passing years. Throughout this entire period the fisheries were consistently neglected and the fact that the economic structure of the island rested upon the fisheries was disregarded.

As a result of the economic depression, for four successive seasons from 1930 to 1933, the fisheries yielded no returns. In 1932 the price for fish reached the lowest level recorded in the present century. By 1933 Newfoundland was on the verge of bankruptcy. Because of excessive borrowing and maladministration, interest charges were now absorbing one-half the revenue, and direct relief one-quarter of the revenue; there were no funds to rehabilitate the fisheries to meet foreign competition.[12]

Prior to 1933, no attempts were made to assess the market requirements of the consuming areas. In 1933, the Salt Codfish Exportation Board was established but was unable to cope with the depressing trading conditions that existed in foreign markets. In 1936 the Newfoundland Fisheries Board was established, mainly to direct biological and economic research into the fisheries.[13] Its main impact on the floater fishery was to demand a standard quality of cure from the industry. The board introduced cooperative marketing and export inspection of codfish in 1936. It organized and established the Portugal Exporters Group Limited, which was given the sole right to sell and export salted codfish to Portugal. The success of this group resulted in the formation of similar groups between 1936 and 1943, covering sales and exports of salted codfish. Several years of group marketing followed, and in 1947 with direction from the Newfoundland Fisheries Board, five exporting organizations merged to form the Newfoundland Associated Fish Exporters Limited (NAFEL). However, the benefits from these organizations came too late to save the floater codfishery.

TECHNICAL STRUCTURE OF THE INDUSTRY

Fishing Operations

During the peak of the floater fishery, flotillas of schooners set sail from St. John's, Harbour Grace, Port Union, Catalina, Bonavista, Twillingate and from numerous small ports on the east coast of Newfoundland. On the Labrador coast the schooners congregated

[10] See also *Newfoundland Royal Commission 1933 Report* (London: H. M. Stationery Office, 1934), pp. 76–110.

[11] *Ibid.*, p. 81.

[12] The major production exported from Iceland and Norway consisted of heavy-salted fish. The loss of first place in the European markets for the Labrador product was accepted by the Newfoundland exporters with indifference. They argued that no country could compete with Newfoundland's hard-dried, light-salted, shore cures. Had Iceland and Norway been producers of light-salted fish, the Newfoundland industry would have been compelled to organize and to maintain itself on a competitive basis.

[13] In 1931 the Fisheries Research Bureau was established in Newfoundland, with a fishery research station located at Bay Bulls for the purpose of conducting biological research into the principal fisheries of Newfoundland. The Bureau became the Newfoundland Fisheries Board in 1936. The only other attempt to study the fisheries was by the Newfoundland Fisheries Commission from 1890 to 1898.

at numerous harbors, especially among the islands. It was customary for 30 or 40 schooners to operate from such harbors as Indian Harbour, Batteau, Spotted Islands, Grady, and Packs, to name only a few. The floaters, often from the same home port, were in the habit of visiting the same harbors year after year. This practice made them familiar with the fishing areas. If the fishery was poor, they navigated passages that had been proven safe by previous experience. Generally they occupied the more seaward harbors and rarely entered the bays except to secure firewood. Communications concerning the condition of the fishery were passed by word of mouth from skipper to skipper of passing vessels.

The difficulties of navigating an uncharted coast that abounded with rocks, experienced heavy coastal fogs, and was subject to sudden gales—80 schooners were lost in severe gales that swept the coast between October 12 and 15, 1885—led to the use of certain harbors as focal or rallying points. It was not unusual for 25 schooners to lie in Indian Harbour while within a radius of 5 miles 300 more would be waiting a week or more for fine sailing weather to cross Groswater Bay.[14] Indian Tickle, lying midway between Indian Harbour and Battle Harbour, provided a convenient midway point that could be reached in a day's sailing. The Battle Harbour area was a similar focal point for schooners waiting for the fog to lift to cross the Strait of Belle Isle on the return voyage in the autumn. Quirpon served in a similar capacity when schooners were northbound in the spring. This pattern was still followed after World War II, as most fishing vessels depended on sail as a primary source of power. The pattern was, therefore, similar to that of the earlier ship fisheries.

Most of the floater fishermen lived in small port communities or "outports" on the east coast of the island of Newfoundland, from Notre Dame Bay to St. John's.[15] In this area were located the main commercial interests that purchased and exported the Labrador fish and also supplied the industry with the equipment and credit necessary to exploit the fishery. Also in this area were located the yards where the floater schooners and trap boats were built. In boat building and ship maintenance the floater fishermen of the outports had practical experience.

Preparation for the next season's fishery began immediately the current season's operations ended. In the autumn, the vessels were cleaned and anchored for the winter in sheltered coves that were free from rafting ice. Codtraps were woven or repaired in the net loft from December to April. In early spring, from March to June, boats were built, repaired or painted, nets "barked" or tanned, and all gear overhauled for the fishery.

The floater crews "went in collar," or were taken on, from May 1 to 10; a period of 4 to 8 weeks was necessary to outfit the vessel. This preparation involved the cleaning, soaking and washing of the decks and holds, preparation of sailing and fishing equipment, painting, and the stowing aboard of food, salt, fuel, and gear. The amount of salt taken on board depended on the estimate of the catch for the voyage. About 250 to 300 hogsheads of salt were taken to salt down 1,200 quintals of fish. Vessels with larger crews carried two or three trap boats, and those with smaller crews a single trap boat.

The vessels set sail for the Labrador coast during the last week of June or the first week of July, the date of departure depending on the weather. About a week later, the vessels anchored in a sheltered harbor and the codtraps were placed in the water where cod were reported to be running. When the cod were reported running offshore, the fishermen waited for them to come inshore before setting the traps. If the run proved poor, the fishermen would move on to the next cove. At such times the schooners would gradually work northward with skippers reporting by

[14] H. L. Paddon, "Vale, Indian Harbour," *Among the Deep Sea Fishers*, Vol. 27, No. 3 (October 1929), p. 108. Numerous accounts of the floater fishery are to be found in the earlier issues of this International Grenfell Association publication.

[15] The Newfoundland fisheries were composed of four main branches; namely, the Labrador floater, Labrador and Newfoundland stationer, Newfoundland shore, and the "Banks" or deep sea fisheries. The Labrador and Newfoundland stationer fishery was composed of two parts. First, the Labrador or "liveyere" shore fishery was carried on by the resident population of the Labrador coast, and secondly, the Newfoundland stationer shore fishery was carried on by Newfoundland fishermen who sailed to the Labrador coast each summer to fish, and who operated from permanent shore-based fishing stations.

word of mouth on the local conditions of the cod-run. If the cod-run was exceptionally good a full voyage might be made in 3 to 4 weeks. The floater then returned to his home port in August. The fish might be sold immediately in salt bulk, or the fishermen might decide to "make" or cure the fish during September and October before selling it. In a year when the run of trapfish was poor, the floater fishermen continued fishing with trawls, handlines, and jiggers until the end of September or October. To make a full voyage with this equipment took considerably longer, so that the cure might not be completed until mid-November. After the fish were disposed of, the schooner was "put up" for the winter. Schooners that returned from the Labrador fishery in August often engaged in coasting work, particularly in the shipping of sawn lumber from mills to the outports. The floater fishery season had an average duration of from 4 to 6 months.

The floater depended mainly upon the catch taken from the codtraps. The cod-run usually lasted from 2 to 6 weeks and began about the third week of June and continued to the end of July or to mid-August. North of Groswater Bay the cod-run began from July 15 to 30 and continued to August 15 or 30. North of Cape Mugford the cod-run began one to two weeks later. Occasionally when the season was late or ice had remained on the coast into mid-July, the cod-run was of short duration or it did not occur. At other times the cod appeared suddenly on the coast and disappeared as rapidly.

The appearance of the cod is related to the caplin "scull." Each summer with unusual regularity caplin appeared in large shoals on the coastal fringe to spawn. Caplin, a small silver-sided fish about 5 to 6 inches long, spawned from beach-level down to a depth of 40 fathoms. Temperatures favorable for spawning ranged between 42°F. and 47°F.; but in the deeper water spawning occurred between temperatures of 36°F. and 39°F.,[16] providing for a possible spawning range of 11 degrees. After spawning, the caplin became inactive and in beach spawning they were often washed up on the inshore beaches of the mainland and the islands. The period when the caplin were inshore coincided with the period when the cod were inshore, and hence the duration of the trap-fishery. At this time the cod, which also had recently spawned, fed mainly on the caplin and its run-down condition recovered rapidly. At the beginning of the season 75 percent of the cod were small and thin, but by the end of July when over 90 percent of the fish were thick and fat, their weight had about trebled. In the coastal area south of Groswater Bay the cod were in prime condition in August, but in the Cape Mugford area they reached prime quality in late September or October, at a time when rough weather was frequent. North of Groswater Bay the arrival of caplin was uncertain, although schools of lance, a smaller fish than the caplin, appeared on the inshore waters to be followed by shoals of codfish.

The cod berths and trap sites were set where it was known from experience that the current or incoming tide would carry the caplin close inshore, pursued by the feeding cod. One trap was set at each berth. At the berths the water usually exceeded 10 fathoms; most traps were placed in berths of from 20 to 24 fathoms, but a few in 30 fathoms. The berths were located in low saddles on the sea floor close to cliffs, rocky shores, or submerged rocks and reefs. The trap season was usually longer, and catches of cod were usually larger and heavier in the deeper berths than in the shallower berths. Two to four berths were often used in the course of a season. It frequently happened that cod would be running inshore a few miles away, but in the immediate vicinity of the schooner the cod had not "struck in." The fishermen had learned to recognize incoming and outgoing movements of the cod and to make the necessary adjustments in fishing. Generally there were no regulations to determine who should get any special berth; a berth was normally claimed by the floater who arrived first and placed a trap in the water. It was customary for the floater fisherman to place his traps in those berths that he had previously trapped, as he had to be familiar with the physical conditions of the berth site, such as the set of the current, the slope of the shore, the occurrence of rocks and ledges, in order to realize satisfactory catches.

[16] W. G. Templeman, *The Life History of the Caplin* (St. John's: Newfoundland Fisheries Board, 1948).

The codtrap berths were graded choice, prime, seconds, and fly, in that order, according to the run of fish taken from them. The choice berths provided large catches and were fairly dependable from year to year; the fly berths provided poor catches even when the coast experienced a good run of fish. Although the fly berths represented the lowest grade of berths, they indicated places where the cod approached close to the shore and where a trap could be set.

The floater fishermen recognized the coastal area, not so much by names on a map, but by the names of the cod berths. The Newfoundland floaters often called an island by several names, depending on the origin of the floater's crew. When a berth was discovered, it was given a distinctive name, such as "Lady Bight," "Crack in the Wall," "Pot of Gold," "Pidgeon Gulch," "Golden Slipper," and so on. Many of these have been known for over half a century. (See Figure 1B for the names of berths around Belle Isle.) Berths were classified as "inside" or "outside," outside being those located on islands or headlands and exposed to rough seas. Inside berths were those that were sheltered from heavy seas and were trapped when the seas were too rough to trap on the outside berths.

The major floater area extended from Groswater Bay to Mugford Tickle. This area, marked by promontories jutting well to seawards and by groups of large islands separated by deep channels, provided a "zone" where cod trapping could be carried on. The "prime" trapping areas appeared to have a concentration of berths, so that traps could be set as close as 80 fathoms. The fishing grounds about White Bear Islands, Holton Harbour, the Cape Harrison–Jigger Tickle area, and the "Queen's Lake" area (near Nain) had some 100 berths each. Large offshore rocky islands almost invariably had an extensive number of berths; thus, Belle Isle had 43, Cod Island 32, Cut Throat Island 20, and Solomon Island 30. Usually only the prime and choice berths were used, except when a large number of floaters were fishing in the area or a heavy run of fish occurred.

The distribution of berths and fishing grounds in the Cape Kiglapait–Cape Mugford area and around Belle Isle are shown in Figures 1A and 1B.

Floater Fishing Equipment

The floater fishermen depended mainly upon the codtrap, a plan of which is shown in Figure 2.[17] The traps varied in size from 40 to 75 fathoms "on the round," or the distance around the top of the four rectangular walls of the trap. Most were in the 50- and 60-fathom class. The traps varied in depth from 10 to 13 fathoms, some being specially woven to meet the conditions of a particular berth site. With care, a trap might be used from 3 to 6 years without requiring any major repairs.

The codtrap was one of the most productive methods of fishing; it was not unusual for a trap set on July 25 to have caught 800 quintals of fish by August 10. The trap was developed as a means of capitalizing on the extensive shoals of cod that invaded the inshore waters; moreover, bait supplies were not required for its operation. It was simple to construct, practical to operate, and economical when considered in terms of the volume of fish caught by other methods of fishing.

During the trapping season, the fishermen, depending on the run of cod, usually made two to three trips a day to haul up the traps (Fig. 3). Surplus fish were usually put into cod bags and then lowered into the water to be collected on the next trip to the trap.

In seasons when the run of trap-fish was poor, the fishermen turned to the use of trawls, handlines, or "jiggers" and fished on the trawling banks which lay from 2 to 5 miles offshore (see Fig. 1B for banks around Belle Isle). Trawls varied from 200 to 600 fathoms in length; 18-inch long "sud-lines" with hooks were attached at about 3-foot intervals along the main line. A 500-fathom trawl-line would thus contain about 1,000 hooks, and was usually worked by two men from an open boat. In good years the trawls were often used after the peak of the trap fishing had passed, yet while supplies of caplin were still available for bait.

Handlines consisting of a single baited hook were often used. Four to six of these lines were worked by two to three men from a small open boat anchored over the fishing bank.

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[17] Mark Ronayne, "The Newfoundland Codtrap," *Trade News*, Vol. 9, No. 4 (October 1956), pp. 3–7. This article contains a popular account of the Newfoundland trap net.

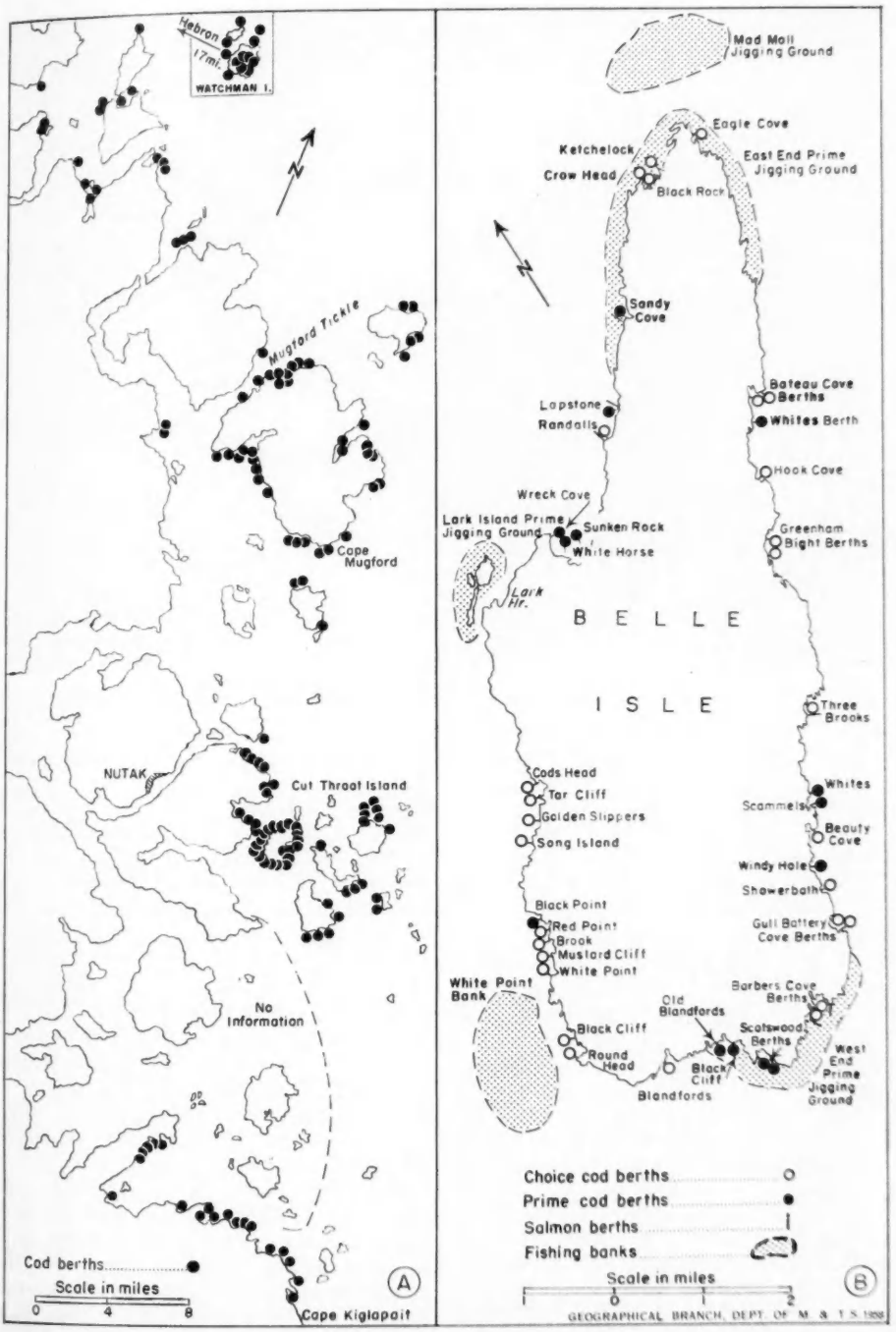

FIG. 1. A. Location of choice and prime cod berths in the Nutak area.
B. Location of choice and prime cod berths, salmon berths and fishing banks around Belle Isle.

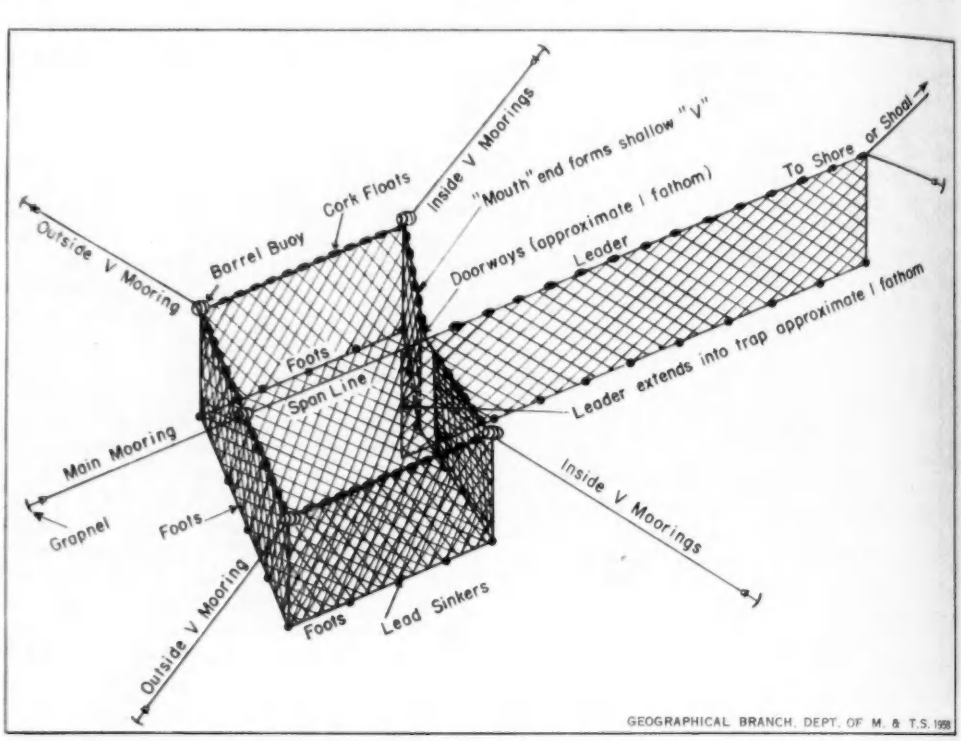

FIG. 2. Diagram of a codtrap in fishing order. All codtraps are similar in construction but they vary in size, and costs range from $1,400 to $2,500. (Courtesy "Trade News," Department of Fisheries, Canada.)

When live bait was unavailable, salted herring was used. Fishing with handlines and trawls was carried on in late August and September, even during foggy and inclement weather. In a good season the lines yielded about one-eighth the catch of a codtrap.

All floaters were equipped with a variety of jiggers. The jigger, a lead replica of a fish, fitted with two large up-curved hooks, was attached to a long line. The fisherman, drifting in a small open boat, fished by jerking his line up and down. This process attracted the cod which were hooked in the mouth or side. This was not a popular method of fishing as jiggering appeared to drive the fish away, and it was believed that at least one-third of the fish escaped off the jigger and were lost.

The use of the codtrap resulted in the development of the trap boat carried by the schooner. This boat was used to haul the fish from the codtrap and, when fully loaded, had a capacity of 30 to 35 barrels.

As the floater fishery was an extension of the inshore fishery carried on around the shores of the island of Newfoundland, the schooners were used as a mobile base of operations, and therefore represented the major piece of capital equipment. In the last three effective years of the industry's existence, 1948, 1949, and 1950, the fishery was carried on by a fleet of 180 schooners. Seventy percent of this fleet was built between 1920 and 1939. About 20 percent of the fleet was added in 1935, a "boom" year in schooner building. The good prices prevailing for fish in the decade during and following World War II encouraged construction of new floater vessels (Table 1).

About 85 percent of the schooners (153) were built in Newfoundland and 15 percent were constructed outside the province, mostly in Nova Scotia. The schooners were built mainly in the scattered outports around the eastern coast of Newfoundland; Notre Dame Bay accounted for 20 percent, Bonavista Bay 31 percent, Trinity Bay 23 percent. The re-

FIG. 3. Bailing fish from a codtrap into a trap boat. (Courtesy "Trade News," Department of Fisheries, Canada.)

mainder were built in southern outports extending from Conception Bay to Fortune Bay. About 13 percent of the fleet were re-built vessels; the oldest schooner afloat was built in the state of Maine in 1885 and re-built in 1925.

The Labrador schooner was a heavy-ballast, deep-draught, gaff-rigged vessel built of spruce (Fig. 4). The depth and beam-to-length ratios varied with the size of the schooner. For example, vessels of 60 to 90 tons had a ratio of 1:3.4:8; length, 65 to 87 feet, beam, 20 to 24 feet, and depth, 8 to 10 feet. The wide beam and deep-draught feature of the floater schooner was a Newfoundland development to meet the fishery's requirements for a large storage hold and stable riding qualities.

These schooners relied for the most part on sail; however, about three-quarters of them were equipped with small gasoline or diesel engines as auxiliary power. Engines were used mainly against adverse winds and in navigation among the narrow passages and harbors of the rock-bound, island-strewn coast. The engine-powered floater could easily be handled by a few men. The floaters seldom carried navigational equipment or power winches; sails and anchors were hoisted by hand. Few were equipped with wireless; few even had radios or electric lights, and the crew's quarters more often than not were heated by a wood-burning stove.

After the fishery was completed, the traps were taken up, dismantled, spread and dried

TABLE 1.—CONSTRUCTION PERIOD OF FLOATER VESSELS USED IN YEARS 1948, 1949, AND 1950[1]

Construction period	Floater vessels	
	Number	Percent
Prior to 1919	16	8.8
1920 to 1929	62	34.4
1930 to 1939	63	35.2
1940 to 1949	39	21.6
Total	180	100

[1] Source: Canada, Department of Transport, *List of Shipping—being a List of Vessels on the Registry Books of the Dominion of Canada on the 31st of December, 1950* (Ottawa: King's Printer, 1951).

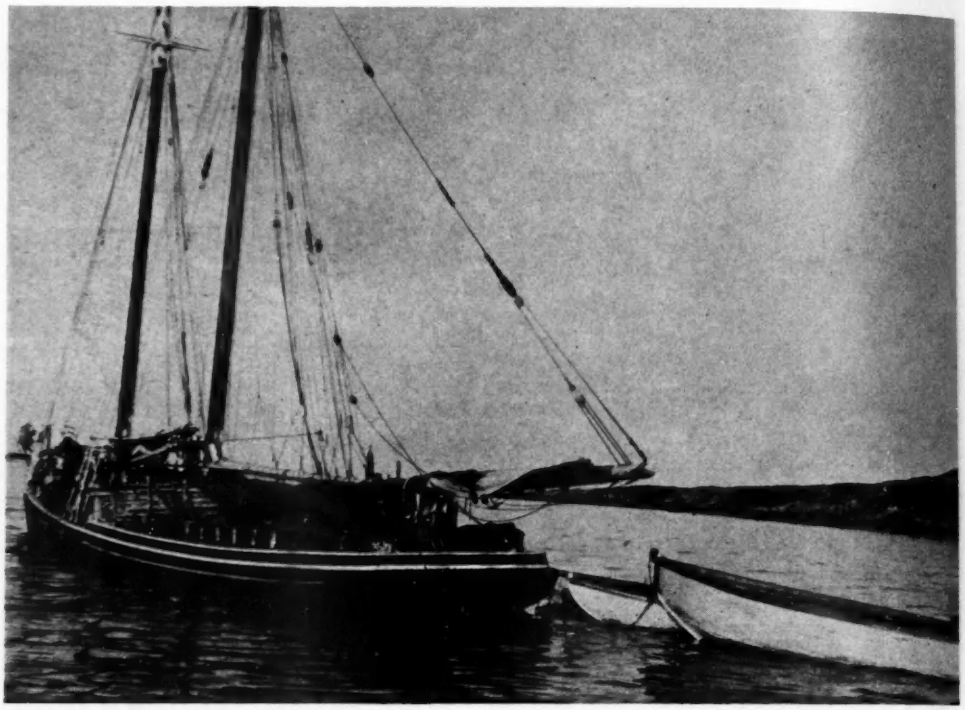

FIG. 4. Labrador floater schooner with a trap boat tied to its stern. As the low-riding schooner has made a full voyage, casks, fishing gear, and firewood are securely fastened down on the deck in preparation for sailing home. (Courtesy "Trade News," Department of Fisheries, Canada.)

on the rocks, and then stowed away. A day or so later in fine weather the schooners weighed anchor and set sail for their home ports. In late August and September when days were shorter, and storms and blustery weather more frequent, they sailed southward keeping close to shore and anchored each evening in a sheltered cove. Often it took two to three weeks for the floater to return to his home port.

Fish Processing

The preparation of the fish for curing began with the forking of the fresh cod from the trap boat to the deck of the schooner. The fish were then piled beside the splitting tables (Fig. 5), the number of splitting tables in use depending on the size of catch and the number of fishermen available to process the fish. First the "cut throater" opened the fish, the "header" removed the entrails and cut off the head, and the "splitter" removed the "sound" or backbone. A fourth crewman was usually required to fork fish to the table, to wash it, and to move the fish into the hold. The "salter" working in the vessel's hold stacked fish between layers of salt.[18] During periods of large catches, the work of going to the traps and the processing of the fish continued for 18 hours a day until the voyage was completed.

At the beginning of the season, livers were considered worthless as the oil yield was too small. By August, however, when the fish became fat, livers were stored in wooden casks to ferment in order to produce sun-rot oil. At this season four gallons of livers yielded about one gallon of oil. The amount of oil extracted by fermentation was about one-quarter to one-half of that produced by liver-rendering plants, and in addition, sun-rot oil had about one-half of the commercial value of the latter. In the autumn, schooners with full cargoes of fish

[18] Adding the vessel's cook, this group would make a 6-man crew.

FIG. 5. Cleaning fish on the deck of a schooner. The fish bin is so placed that the fish are accessible to the "cut throater"; the fish are then passed on to the "header" on the right, and across the splitting table to the "splitter." The split fish are washed in the wooden tub, then moved through the hatch into the hold to be stored in salt bulk.

usually returned with 4 to 12 casks of oil aboard.

Because of the long period that fish remained under salt before curing, the heavy-salted method of curing was practiced among the Labrador floater fishermen.[19] In addition, the production of the more valuable light-salted cure was largely prevented by the nature of the floater operation, by frequent occurrence of bad weather, and by the considerable risk of infestation from fly-maggots and fungus. Salt, which acts as a dehydrating preservative, was the only material used for curing; the use of additional amounts eliminated the need for intensive drying. The floater fishermen applied one hogshead of salt to four quintals of fish, although the actual amounts varied considerably. Usually too little salt was used, especially at night when the salter worked under the dull light of a kerosene lamp. The fishermen considered that a good grade of heavy-salted fish should be sound, well split with no torn flesh, thoroughly cleaned and fully salted; its surface should be firm and clear, but not wet, soft, or hard-dried. Salt-bulk fish was frequently called "Labrador slop" because its flesh tended to be soft and soggy.

After the floaters returned to their home ports, the salt-bulk fish might be disposed of immediately to merchants, or retained by the crewmen for curing during September and October. To remove the fish from the floater's hold required from a few days to two weeks; the fish were washed and then spread out on fish "flakes" or wooden drying racks to dry. Two full days of sunlight were required to produce the ordinary Labrador cure of salt codfish. This was necessary to form sufficient "crust" to keep the fish from spoiling. Fre-

[19] For an account of the traditional method of curing codfish, see N. L. Macpherson, *The Dried Codfish Industry*, Newfoundland, Department of Fisheries, Fishery Research Bureau (St. John's, 1935).

TABLE 2.—HOME AREAS OF SCHOONERS ENGAGED IN LABRADOR FLOATER FISHERY FROM 1948 TO 1950[1]

Home area	1948 Number	1948 Percent	1949 Number	1949 Percent	1950 Number	1950 Percent
Notre Dame Bay	52	39.7	50	35.2	10	15.4
Bonavista Bay	61	46.6	72	50.7	36	55.4
Trinity Bay	10	7.6	13	9.2	9	13.8
Conception Bay	4	3.0	2	1.4	3	4.6
Other areas	4	3.0	5	3.5	7[2]	10.8
Total[3]	131	100	142	100	65	100

[1] Statistics provided by the Newfoundland Fisheries Board, St. John's.
[2] These were the seven "bankers" from Fortune Bay.
[3] During the period 180 vessels took part in the Labrador fishery. Many of these schooners sailed each year to the coast, to make up a total of 338 voyages for the 3-year period.

quently, because of fog and inclement weather, the fish received only a few hours of sunlight, and a poor quality of cure resulted. In the autumn, two to three weeks were required for curing. When rains threatened, the fish were stacked in "bulks" and covered. To cure such large quantities of salt-bulk fish required the assistance not only of the floater crew but also their wives and children. As many as 20 to 40 persons were often involved in the curing of a single floater's catch. The fishermen estimated that 275 pounds of green split or fresh fish were necessary to make 112 pounds or one quintal of Labrador semi-dry cure. As quantities of fish were cured they were usually transported by trap boat to the local merchant, graded by him according to quality, and sold.

The Labrador heavy-salted fish were graded as choice, or number one, prime or number two, and "cullage." The latter grade included tomcod, torn fish, or badly cured fish. Much of the salt-bulk fish that was landed at the main ports of Newfoundland was dried in artificial driers for export markets. This product was more uniform in size, quality, and appearance, and was generally superior to the regular air-cured, heavy-salted product.

Production and Distribution of Catch

The production and distribution phases of the industry that were revealed in a study of its 1948 to 1950 operations are considered also to be representative of its past operations. Table 2 shows that during these years 50 percent of the voyages (169) originated in the outports of Bonavista Bay. Prior to World War I, Conception Bay and St. John's were the main bases of the floater operations. The gradual migration of the industry northward to Bonavista and Notre Dame bays was caused mainly by the expansion of the inshore fishery in the Conception Bay area and also by increasing economic opportunity in the St. John's area.

The location of the fishing areas on the Labrador coast during these years is shown in Figure 6. Although one-third of the schooners did not report their fishing areas, the pattern shown may be considered representative of the fishery. The principal area of the fishery extended from Groswater Bay to Mugford Tickle. Although the concentration of ships in specific locations varied from year to year, there were areas that normally experienced a large concentration of floaters, such as the "Queen's Lakes" area near Nain, Cutthroat Island, Ironbound Islands, Indian Harbour, Packs Harbour, Grady Islands, and Belle Isle. Belle Isle, at the eastern entrance to the Strait of Belle Isle, was always an important base for the floaters. In the 1950 season, the fishing vessels were concentrated chiefly between Batteau and Cape Harrison. As this area experienced a heavy run of fish, there was no need for the floaters to push northward. The northern coastal area from Mugford Tickle to Cape Chidley was occasionally fished, but only when the fishery failed in the southern parts of the Labrador coast. The production figures shown in Figure 6 are based on the locations from which the fishermen operated. The small catches are associated with the operation of crews from one or two vessels based at isolated harbors; the larger catches are associated with groups of schooner crews fishing in the vicinity of various harbors.[20]

The fluctuation in the size of catches per vessel and by fisherman varied widely (Table 3). Essentially, production was marked by extreme ranges, the 1950 catch per fisherman being 40 percent greater than the 1948 catch. This range emphasizes the speculative nature of the industry at the production level.

As floater fishermen were concerned chiefly with the production of the Labrador semi-dry or ordinary cure, this type of cure amounted to 95 percent of the total floater production (Table 4). The production of light-salted

[20] Statistics for Figures 6 to 18 were provided by the Newfoundland Fisheries Board, St. John's.

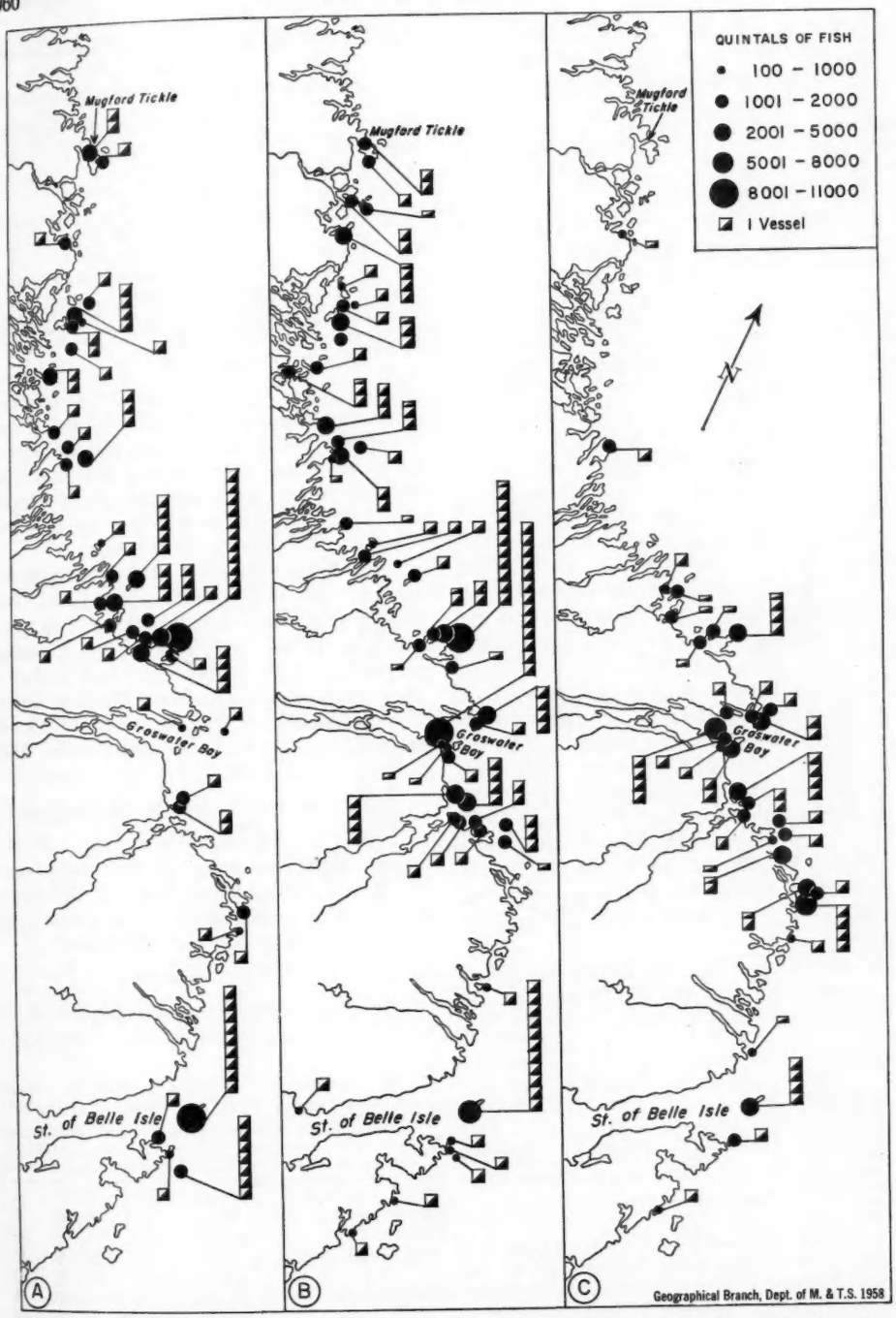

FIG. 6. Variation in floater fishery production, 1948, 1948, and 1950. In 1948 the productive area was between Groswater Bay and Mugford Tickle (Fig. 6A). In 1949 the productive area extended south to Sandwich Bay (Fig. 6B), and in 1950 the principal area extended from Batteau to Cape Makkovik (Fig. 6C).

TABLE 3.—LABRADOR FLOATER FISHERY PRODUCTION FROM 1948 TO 1950, IN QUINTALS[1]

	1948	1949	1950
Number of vessels	81	102	46
Total catch[2]	69,516	67,509	61,542
Average vessel's catch	804	743	1,052
Average fisherman's catch	95	73	121

[1] Statistics provided by the Newfoundland Fisheries Board, St. John's.
[2] About 2 percent of this catch was taken on the Treaty Shore of the White Bay district.

and uncured salt-bulk codfish was negligible,[21] the former averaging about 1 percent and the latter 4 percent of total production.

At the completion of the fishery season, fish were landed chiefly at the east coast ports shown in Figure 7, A and B (see also Table 5). In 1949, 37 percent (44) of the vessels reporting landed their catches in the Notre Dame Bay ports; in 1950, only 17 percent (11) of the floater fleet made their landings at Notre Dame Bay ports. This change in pattern reflected the doubts of outfitters, ship owners, and fishermen on the unfavorable markets for Labrador salt codfish, especially of the smaller outfitters of Notre Dame Bay. There was, however, a small reduction in 1950 in the number of schooners operating from Trinity Bay ports, because the larger mercantile establishments were prepared to take the risk for equipping a large part of the Labrador floater crews in 1950.

The quantities of fish landed are shown in Table 6. About 32 percent of the fish in 1949 were landed at Notre Dame Bay ports; in 1950, Trinity Bay ports received 38 percent

TABLE 4.—FLOATER FISH PRODUCTION BY GRADES FROM 1948 TO 1950, IN QUINTALS[1]

Grade	1948	1949	1950
Light-salted	50	1,517	2,105
Semi-dry	102,379	103,951	56,178
Heavy-salted[2]	—	—	10,063
Total	102,429	105,468	68,346

[1] Statistics provided by the Newfoundland Fisheries Board, St. John's.
[2] This production was from six Fortune Bay "bankers."

[21] In the 15-year period prior to 1944, approximately two-thirds of the heavy-salted fish obtained on the Labrador coast were taken by floater fishermen; the remaining one-third was taken by the Labrador-Newfoundland stationers. In 1950, the floater production was surpassed by the stationer, probably for the first time since the beginning of the Labrador fishery.

TABLE 5.—HOME AREAS OF VESSEL LANDINGS, 1949 AND 1950[1]

Home area	1949		1950	
	Number	Percent	Number	Percent
Notre Dame Bay	44	37	11	17
Bonavista Bay	13	11	4	6
Trinity Bay	32	27	27	42
Conception Bay	14	11.5	9	14
St. John's	14	11.5	10	15
Other areas	3	2	4	6
Total	120	100	65	100

[1] Statistics provided by the Newfoundland Fisheries Board, St. John's. Information for tables 5 to 7 was not available for 1948.

of the landings. The effect of the uncertain marketing conditions for Labrador fish is well illustrated in the reduction of fish landings at the Notre Dame Bay ports for 1949 and 1950. In 1949, these ports handled about 32 percent of the floater production. In 1950 this volume had fallen to 12 percent.

From 40 to 49 percent of the Labrador fish were landed at the ports of St. John's, Port Union, and Catalina, the latter two ports being in Trinity Bay (Table 7). A smaller percentage, 9 to 12 percent, were landed at Twillingate, Carbonear, and Harbour Grace. The remainder of the landings (42 to 48 percent), composed of amounts under 5,000 quintals, were landed at small outports.

ECONOMIC STRUCTURE OF THE INDUSTRY

In its financial organization the Labrador floater fishery was based on the arrangements of sharing the costs and sharing the profits through the simple distribution of the catch among the crewmen and merchants.

Share System

The share system, or the division of the catch among members of the crew, was a

TABLE 6.—AMOUNT OF FISH LANDED IN VARIOUS LANDING AREAS, 1949 AND 1950, IN QUINTALS[1]

Landing area	1949		1950	
	Number	Percent	Number	Percent
Notre Dame Bay	28,462	32	8,047	12
Bonavista Bay	8,388	9	5,080	7
Trinity Bay	27,330	31	25,891	38
Conception Bay	11,243	13	12,920	19
St. John's	12,700	14	10,860	16
Other areas	1,332	1	5,548	8
Total	89,455	100	68,346	100

[1] Statistics provided by the Newfoundland Fisheries Board, St. John's.

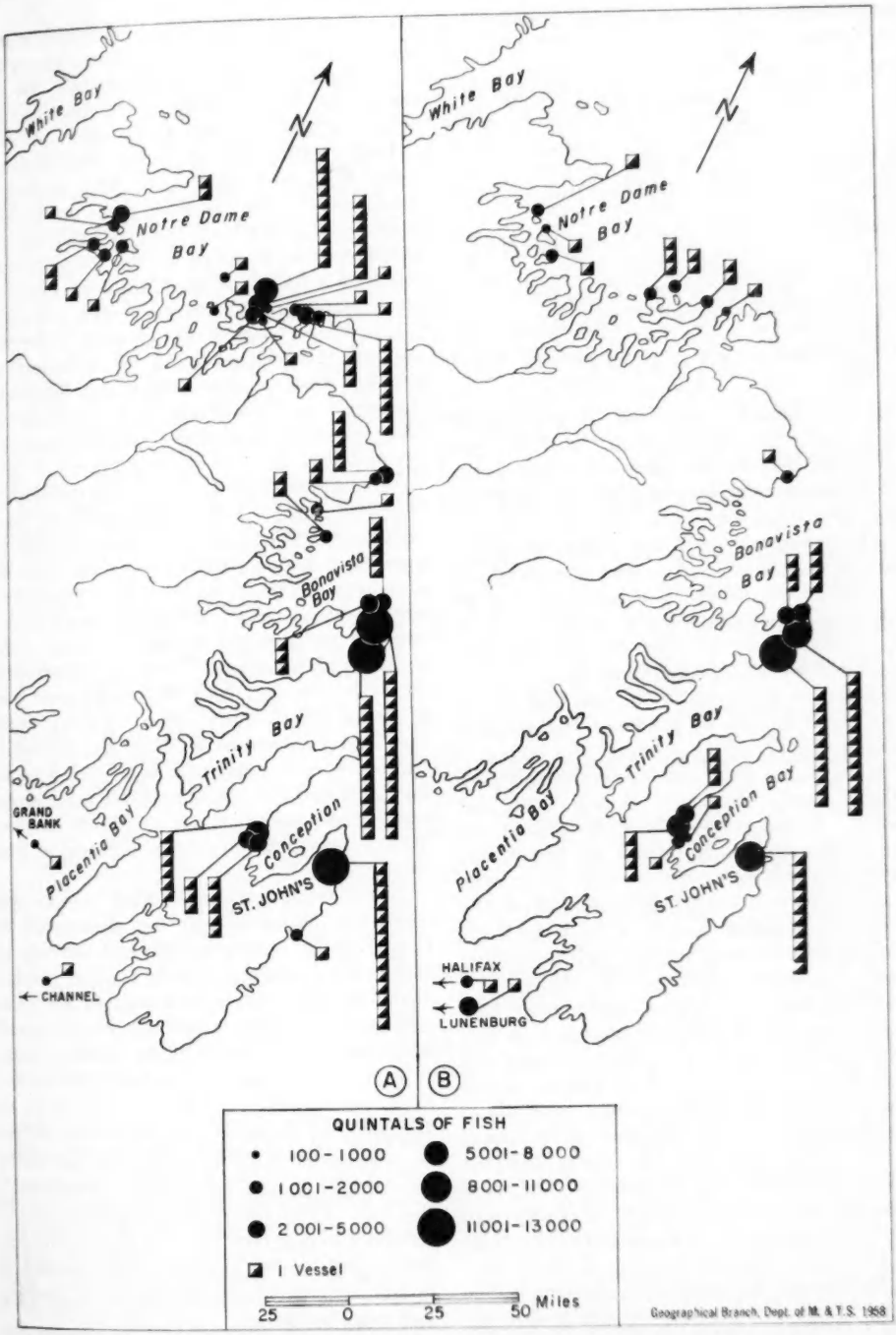

FIG. 7. Floater landing areas in southeastern Newfoundland. Landing areas varied from year to year; the figure illustrates this change for 1949 (A) and 1950 (B).

TABLE 7.—AMOUNT OF FISH LANDED AT PORTS RECEIVING OVER 5,000 QUINTALS OF FISH FOR 1949 AND 1950, IN QUINTALS[1]

Port	1949		1950	
	Amount	Percent	Amount	Percent
St. John's	12,700	14	10,860	16
Port Union	11,332	13	11,590	17
Catalina	11,431	13	10,512	16
Twillingate	5,655	6	—	—
Carbonear	5,213	6	—	—
Harbour Grace	—	—	6,301	9
Total[2]	46,331	52	39,263	58

[1] Statistics provided by the Newfoundland Fisheries Board, St. John's.
[2] Percentage is based on the combined production of 1949 and 1950.

method of sharing the costs of production. This practice had its origin in the credit system of the earlier fish merchants who were store managers, fish buyers, and fish exporters. After deduction of costs, the profits were shared among the crewmen. The estimated share of costs and profits was computed on the basis of the catch. The fisherman's gross wage was thus based on the actual catch of fish, as the fishery was not prosecuted on a cash basis.[22] The importance of the share system was emphasized by the fact that floater crews were known as sharemen rather than as fishermen. The share system was legalized by the Newfoundland government about 1890.

There were numerous variations in the sharing of the catch. Vessels owned by fishing firms were equipped by the firms; privately or independently owned vessels were equipped by the outfitting merchant at the merchant's expense. Costs of both methods were normally borne through each individual vessel's "company account," i.e., the cost of outfitting each vessel was maintained separately from the fishermen's accounts. A few of the more frequent examples of sharing are given below. In a merchant-owned vessel with one trap boat and a 12-man crew, there were considered to be 25 half-shares. In a catch of 1,200 quintals, the shares and the catch were distributed as follows: The merchant required for the vessel a half-share from each shareman or 11 half-shares of 528 quintals. The trap boat was credited with a half-share or 48 quintals. The floater skipper received a full share or 96 quintals. Of the remaining 528 quintals each shareman received a half-share or 48 quintals.

With respect to an independently-owned vessel with an 11-man crew and a single trap boat, there were considered to be 25 half-shares. In a catch of 1,000 quintals the distribution was as follows: The skipper-owner received a full share of 80 quintals, and from each shareman he also received a half-share, giving him a total of 400 quintals. From this amount the skipper paid all operating expenses. Each of the 10 crewmen received a half-share or 40 quintals. The trap boat was charged with a half-share, and the vessel was given a full share of 80 quintals.

If an independent owner did not wish to run the financial risk of outfitting for a voyage, arrangements were made to share the operating and outfitting expenses with the crewmen. At the conclusion of a voyage these expenses were met first; the balance was then divided so that the skipper received a full share, each shareman received a half-share, and the schooner and trap boat were each accorded a half-share. Many of the privately operated floaters were in part outfitted by "absentee" sharemen who took no active part in the actual fishing operations but supplied equipment, credit, or cash. Additional allowance in the share system was made to cover them.

There were numerous other minor variations that entered into the sharing of the catch. Some vessels maintained separate accounts for such items as salt, food, or gasoline. Many of the floaters took part in the spring salmon fishery; this catch was shared equally among the sharemen. On the Labrador coast, cod-oil production, amounting to one or two casks per vessel, was usually retained by the skipper; but on Belle Isle, where cod-oil production might reach 10 or 15 casks per floater, the oil was shared in the same proportion as the fish. Boys received a quarter-share, the schooner's cook received a half or a full share depending on his duties. Other sharing arrangements involved the rental of codtraps and trap boats.

The share system was relatively flexible and was designed essentially to meet local prefer-

[22] The fact that the fishery was not prosecuted on a cash basis was considered one of the major problems facing the fishing industry. *Report of the Fisheries Committee of the National Convention* (mimeographed; St. John's, c. 1946).

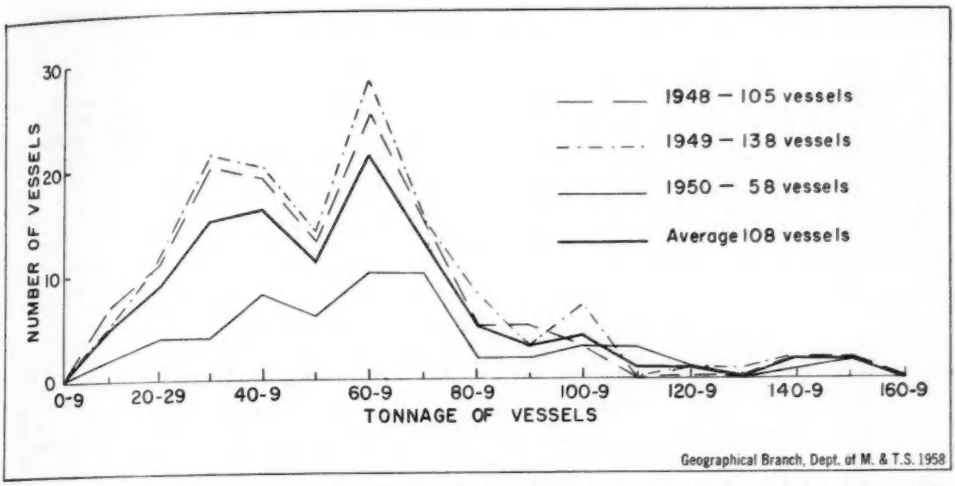

FIG. 8. Annual distribution of vessel tonnage, 1948–50. Two important sizes of vessels are indicated by the graph, the 30- and 40-tonners, and 60- and 70-tonners.

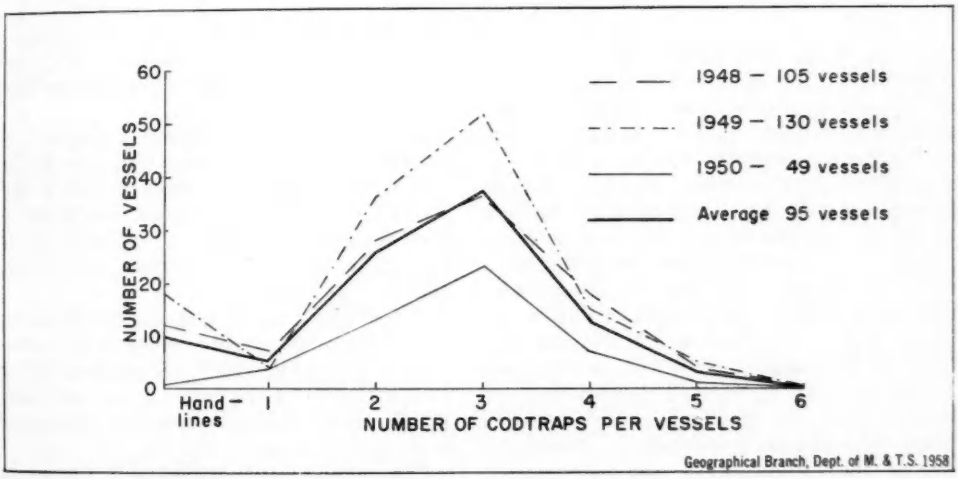

FIG. 9. Annual distribution of codtraps per fishing vessel, 1948–50. The vessel equipped with 3 codtraps is the leading unit.

ences in a community where currency requirements were severely restricted. However, the risk of an unsuccessful voyage confronted both fishermen and merchants each season. The catch depended in large measure on the chance occurrence that cod would move inshore in sufficient quantities to allow for a successful voyage. Many of the floaters each season returned from the Labrador coast with poor catches. This aspect of the fishery, which occurred frequently, emphasizes the risk undertaken by merchants and fishermen engaged in the industry.

Productivity of the Fishery

Evaluation of productivity is necessary to determine whether the industry was prosecuted on an efficient or a submarginal basis. Such an evaluation also provides an insight into factors that have contributed to the decline of the fishery.

The efficiency of an operation is measured

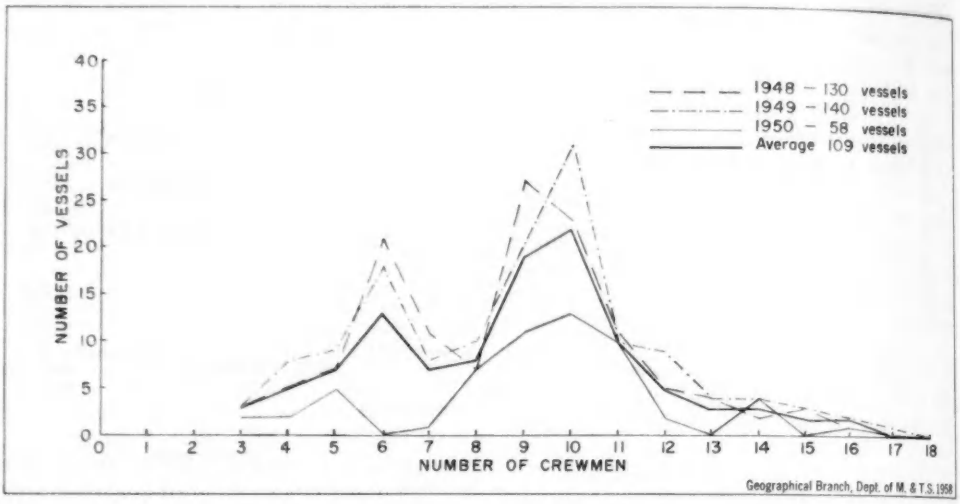
1948 – 130 vessels
1949 – 140 vessels
1950 – 58 vessels
Average 109 vessels
NUMBER OF VESSELS
NUMBER OF CREWMEN
Geographical Branch, Dept. of M. & T.S. 1958

FIG. 10. Annual size of fishing crews, 1948–50. The two peaks of the graph indicate that the 6-man crew and the 9- and 10-man crew were the main floater units.

in terms of its productivity. In the floater fishery, productivity may be defined as the collective output of all vessels engaged in the season's operations. It is determined by several factors: equipment, number of crew, and size of catch. The interrelationship of these factors not only has a direct effect on efficiency of equipment but also has a direct influence on earning power and, therefore, upon the degree of the individual operator's success or failure. These relationships in the floater fishery are examined in Figures 8–17 to show their impact on floater productivity.

Figures 8 to 12 involve relationships associated with the distribution of vessel tonnage, the number of codtraps per vessel, the size of the fishing crews, and catch on an annual basis.

The size of the schooners (Fig. 8), engaged in the floater codfishery ranged from 10 to 159 gross tons. Two significant sizes of vessels are indicated by the two peaks of the graph, the 30 and 40 tonners, and the 60 and 70 tonners, which averaged 29 and 32 percent, respectively, of the total gross tonnage of the floater fleet.

The main fishing equipment is shown in Fig. 9. Most of the vessels were equipped with 3 codtraps (39 percent of the fleet), whereas the 2-trap vessel accounted for 27 percent. Thus two-thirds of the vessels were equipped with 2 or 3 codtraps. Only 11 percent of the vessels depended entirely on hand lines.

The size of the fishing crews ranged from a 3-man crew to a 17-man crew. As Figure 10 illustrates, the 6-man crew and the 9- and 10-man crews are the principal crew organizations. On the average, 37 percent of the floaters were operated by 9- and 10-man crews.

Figure 11 shows the wide fluctuations in the size of the catches as they relate to the various crew organizations. Although productivity per man is higher for the larger crews, each additional crew member does not necessarily guarantee a larger catch.

The annual catch varied with the season and with the size of the crew (Fig. 12). The floater skippers considered that for a successful voyage each fisherman must average one hundred quintals. This assessment was also in line with the experience of the local fish merchants. On this basis, the average annual catch of 1949, which did not reach the 100-quintals-per-fisherman level, was thus not a successful fishery. In the 1950 season, however, fishing units of 8 crewmen or more had successful voyages. When reduced to an average basis, only a small number of crews exceeded 100 quintals per crewman.

It might reasonably be assumed that the

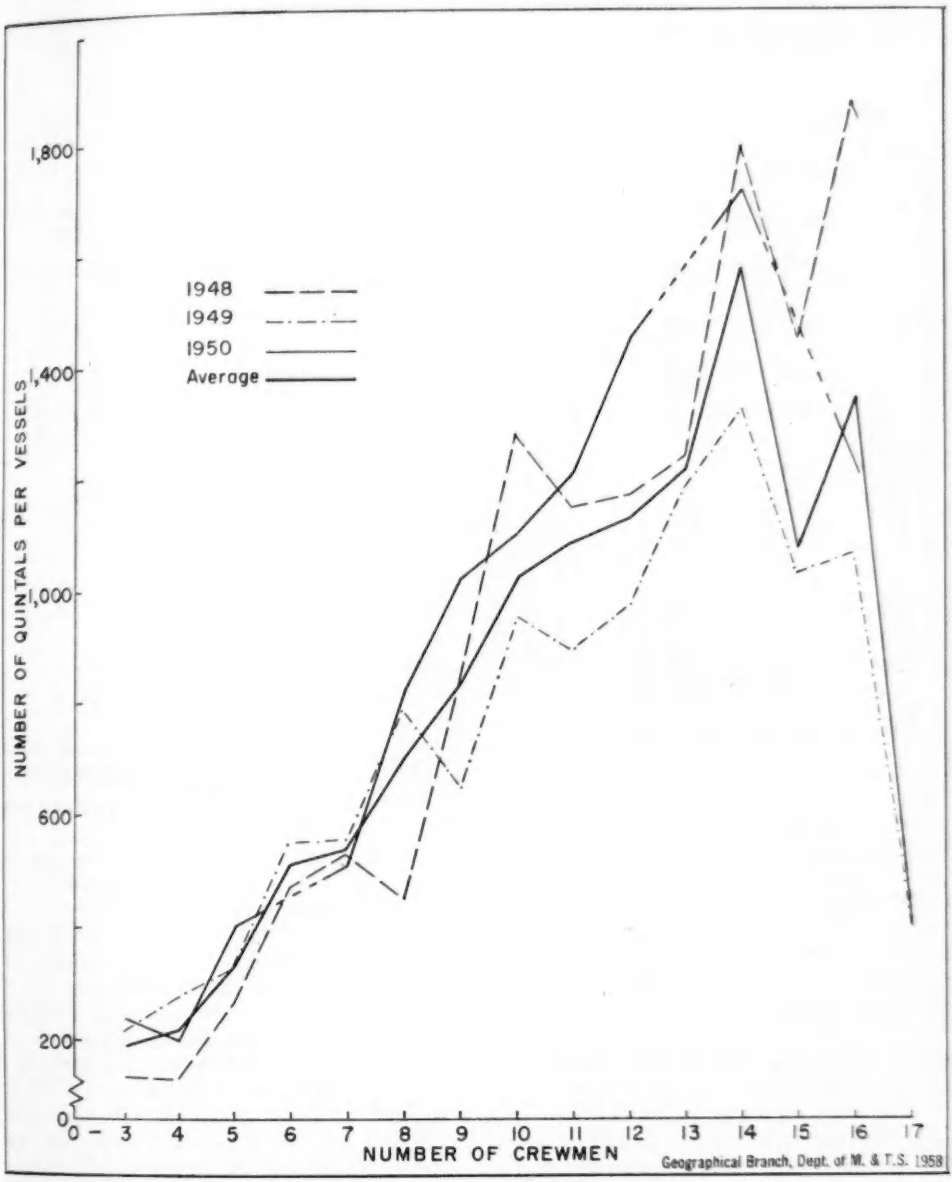

FIG. 11. Annual catch per fishing vessel, 1948–50. Although production increased with size of crew, it tended to be erratic.

larger vessels with the larger crews would be company-owned because the companies would have greater financial resources than individuals and therefore would be able to prosecute the fishery with greater vigor. Figure 13, however, indicates that such was not the case, as the distribution of company-owned vessels parallels those of individual ownership. In the 1949 fishing season, of the 192 vessels taking part in the fishery, 57 were company-

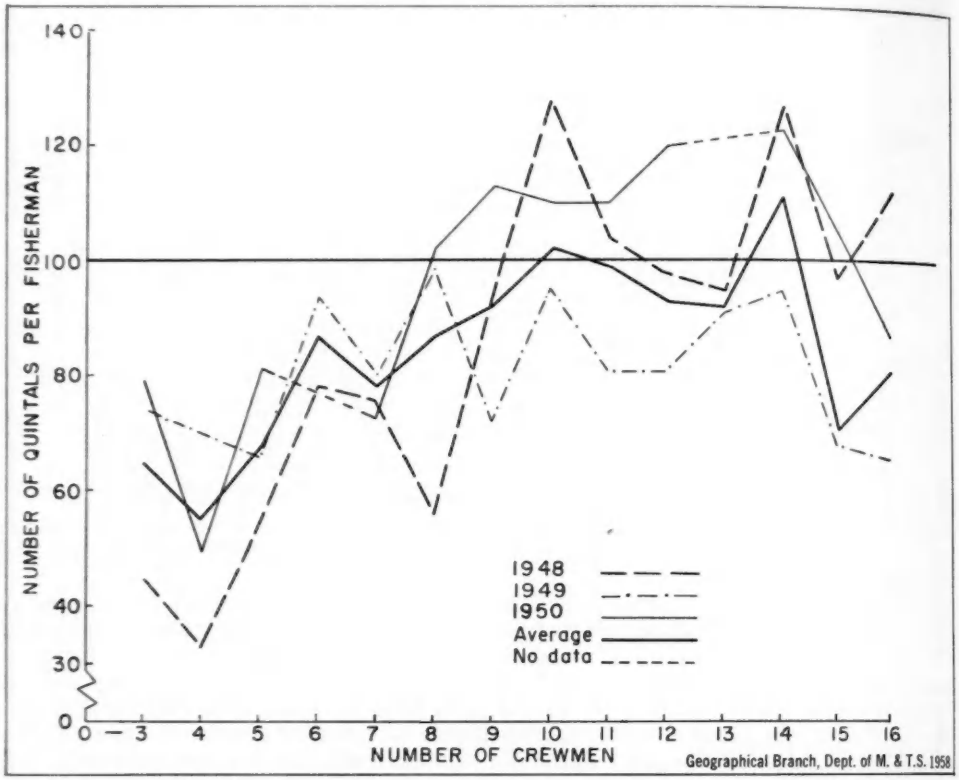

FIG. 12. Annual codfish catch per fisherman, 1948–50. Although the fisherman's catch varied from year to year, in terms of the average, only a small part exceeded 100 quintals per crewman.

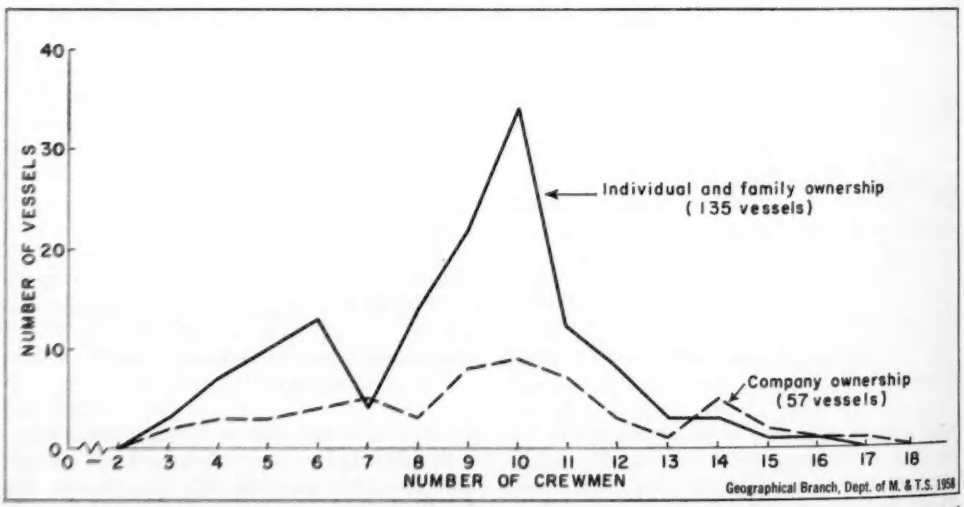

FIG. 13. Ownership of fishing vessels, 1948–50. Ownership of the means of production was not related to the size of the operational unit.

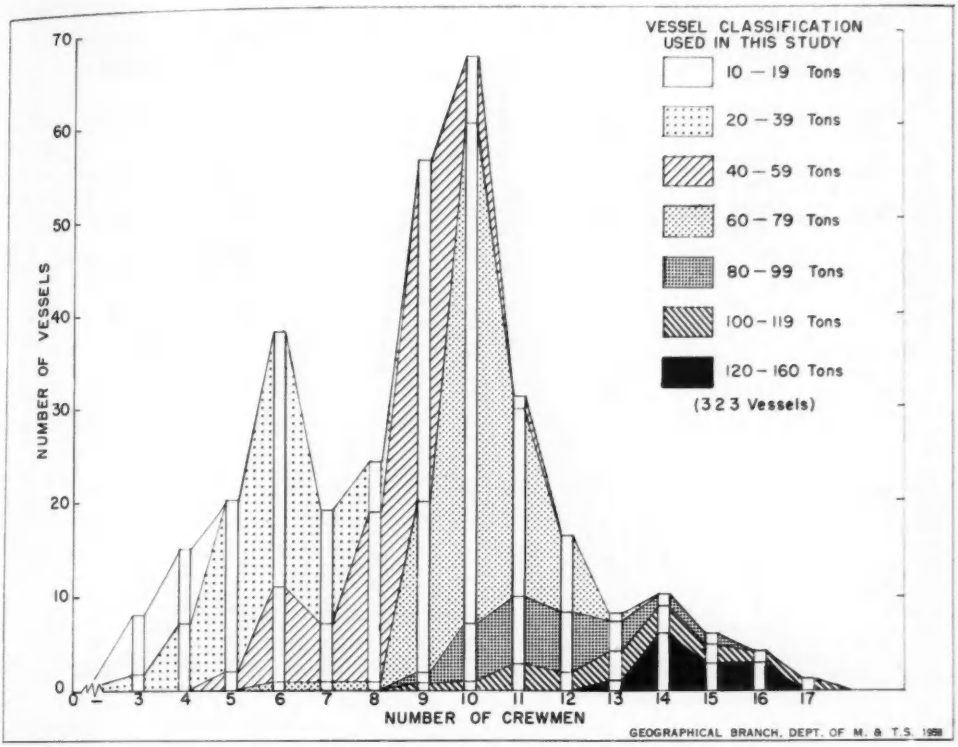

FIG. 14. Cumulative distribution of vessel tonnage, 1948–50. The leading units are the 30- and 40-tonners with a 6-man crew; the 40- and 50-tonners, a 9-man crew, and 60- and 70-tonners, a 10-man crew.

owned and 135 were owned by families or individuals.

Figures 14 to 17 are concerned mainly with cumulative productivity relationships of the fishing organization.

Figure 14 shows the grouping of vessel tonnage in relation to crew organization. It may be observed in this graph that the 9- and 10-man crews are mainly associated with the 40- to 79-ton class of vessel. Although there is a wide range in the distribution of tonnage according to the size of crews, the principal tonnage classes are the 30- and 40-ton vessels in the 6-man unit, and the 60- and 70-ton vessels in the 10-man unit.

The relationship between the number of codtraps and the size of the fishing crew is shown in Figure 15.[23] Of the vessels operated by 6 crewmen, 83 percent were equipped with two codtraps each. Such a fishing unit with two traps in use could maintain one or two splitting tables in full operation. On vessels with 9- and 10-man crews, three codtraps were usually placed in the water, with two splitting tables in full operation, and three tables during rush periods.

The relationship of the codfish catch to the size of the crew is demonstrated in Figure 16. It is evident that the catch per crewman decreases as the size of the crew increases. For example, on the basis of the required 100-quintals-per-fisherman, a 400- to 600-quintal catch at the 4-crewmen level was up to standard. However, the larger crews fell below the accepted standard with the catch per man becoming progressively smaller as the size of the crew increased. A similar relationship is shown for each of the other catches. The 10-man crew, for example, with a catch of 1,000

[23] The fishery from 1948 to 1950 was equipped with 712 codtraps; 31 vessels were equipped with handlines.

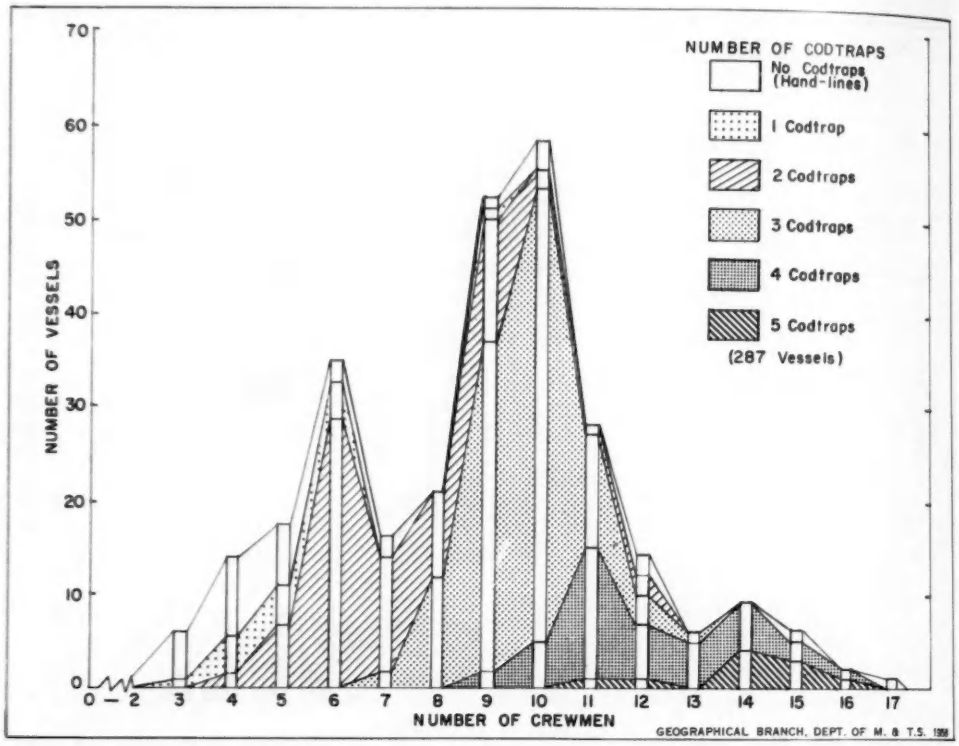
NUMBER OF CODTRAPS
No Codtraps (Hand-lines)
1 Codtrap
2 Codtraps
3 Codtraps
4 Codtraps
5 Codtraps
(287 Vessels)
NUMBER OF VESSELS
NUMBER OF CREWMEN
0 — 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
0 10 20 30 40 50 60 70
GEOGRAPHICAL BRANCH, DEPT. OF M. & T.S. 1951

FIG. 15. Cumulative distribution of codtraps, 1948–50. The 6-man crew usually maintained two traps, and the 9- and 10-man crew, three codtraps. Handlines were used mainly by vessels with small crews.

to 1,199 quintals is above the accepted standard, accounting for 36 percent of the voyages in this category.

An examination of Figure 17 demonstrates that successful voyages were made at all crew levels. Of the 287 vessels engaged in the fishery during the 3-year period 1948–50, only 51.2 percent (147 vessels) had catches of 100 or more quintals per fisherman. However, taking the floater fishery as an operational unit, the most efficient fishing organization is the 10-man crew equipped with three traps, operating in the 60- and 70-ton class of vessels. In this unit of the floater organization, 61 percent of the voyages were successful. On this basis the floater fishery industry would be classified as submarginal.

Relationship of Operating Costs to Net Returns

A number of factors in the past alleviated the effect of a poor catch; in the export field there was a large market for Labrador wet-salted codfish, and in periods of prosperity sterling was freely convertible for the purchase of Newfoundland salted codfish. In the domestic field, the outfitting merchants fixed credit prices at a level to protect businesses against possible losses. There were various opportunities for making a profit, namely, the sale of supplies to the fishermen in the spring; the purchase of fish from the fishermen; the sale of fish for export and the purchase of goods and supplies by the fishermen to carry them through the winter. Should returns from the floater operations not be sufficient to meet the outfitting costs, other phases of the merchants' business could minimize or eliminate the losses incurred by the independents or by the merchants' floater crews.

The price of fish and of consumer goods was fixed by the merchant until the establishment by government statute of floor prices to be paid the fisherman for various grades

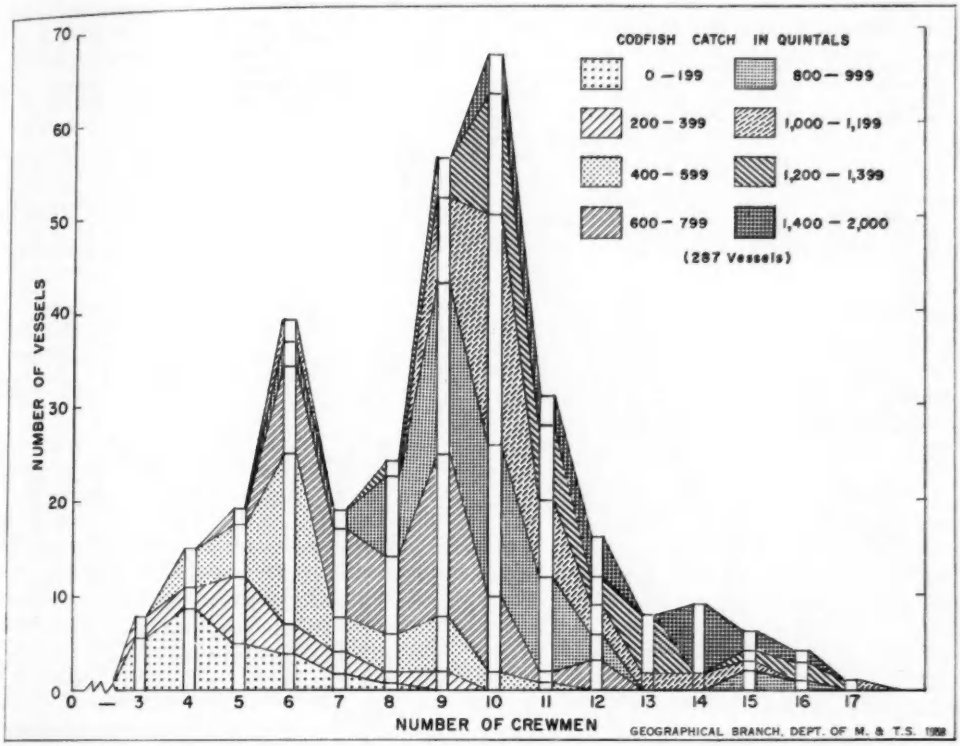

FIG. 16. Cumulative distribution of codfish catch, 1948–50. The catch per fisherman declined with each additional crew member.

of fish during and following World War II. The effect was unusual, especially upon the independent floater. For the first time the fisherman was able to make direct calculations of his probable costs and returns based on a given catch of fish. The effect of fixed prices also reduced the amount of profit derived from the purchase price of fish. Government-licensed inspectors rigidly culled the fish for export, thus narrowing the profit margin from exports. Following confederation with Canada in 1949, Newfoundland families were recipients of Family Allowance checks and such additional income reduced their economic dependence upon the merchants. Cash orders were placed with mail order houses and gradually local merchant prices for dry goods and other staples were reduced. The cost of fishery equipment continued high, but the economic base upon which the floater fishery was sustained had been severely affected.

The floater fishery was a highly specialized industry, depending almost entirely upon the production of salted codfish. The floater unit began operations with a high capital investment. The schooner was estimated to absorb about 70 percent of the investment, with fishing gear such as boats, traps, handlines etc., accounting for the balance. Schooners were generally constructed in Newfoudland at a cost of between $9,000 and $15,000, with fishing gear running between $2,700 and $4,500. The new construction of the 1940's was based on the prevailing opinion that the high wartime prices for Labrador codfish would continue indefinitely.

Against this background of a high capital investment were the high costs of floater production. Table 8 gives a generalized summary of the costs of production for three major fishery groups, each on the basis of a full voyage. These costs cover the period from the outfitting of the crews in the spring to

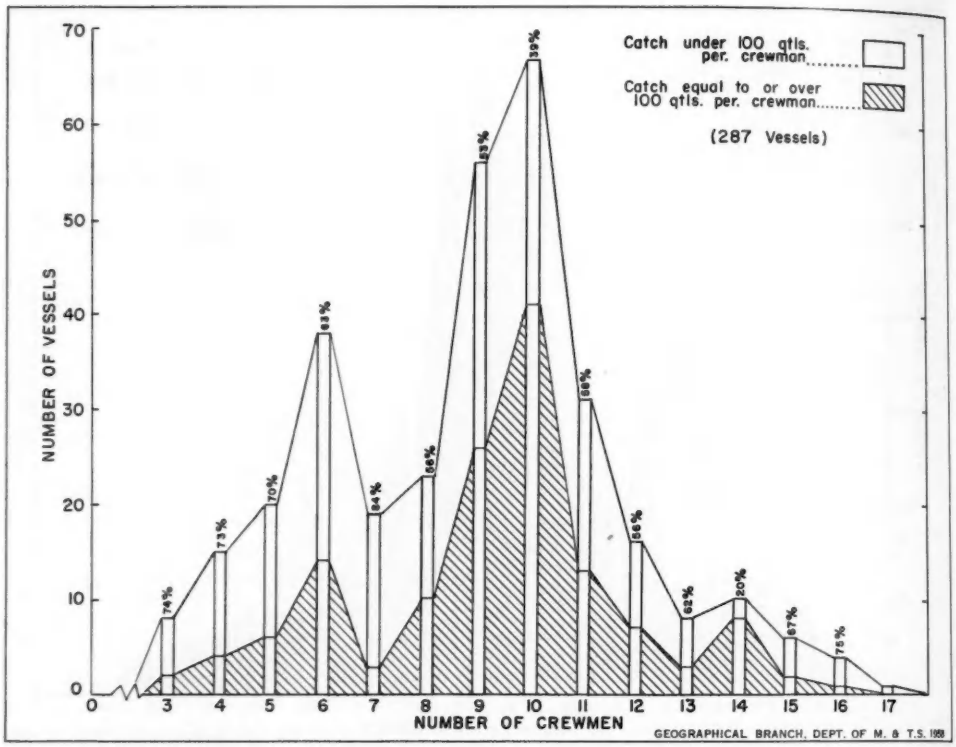

FIG. 17. Cumulative distribution of catch showing the proportion that is greater or less than 100 quintals per fisherman, 1948–50. Poor voyages predominated; successful voyages occurred at all crew levels; the most successful unit was the 10-man crew.

the export of the fish in late winter by a St. John's exporter. The narrow margin between the costs of outfitting the smaller and larger units indicated the shareman's inclination to be associated with the larger floater units. As the size of the fishing unit increased, the average costs of production decreased. In the smaller units these costs absorbed 62 percent and in the larger units 54 percent of the value of a quintal of salted fish. These costs do not take into consideration a 10 percent allowance for depreciation on equipment[24] or an annual 8 percent inflationary rate for new outfitting supplies.[25]

TABLE 8.—COMPARISON OF PRODUCTION COSTS FOR FISHERY UNITS OF DIFFERENT SIZES, IN DOLLARS

Item compared	11 to 12 crewmen	8 to 10 crewmen	5 to 7 crewmen
Size of catch (quintals)	1,200	1,000	700
Outfitting costs[1]	$3,600	$3,400	$3,100
Curing and storage[2]	840	700	490
Freighting[3]	576	480	336
Warehouse charges[4]	2,460	2,050	1,050
Total costs	$7,476	$6,630	$4,976
Total per quintal	$6.23	$6.63	$7.10

[1] Outfitting costs include: gasoline, salt, food, repairs and maintenance of equipment.
[2] Includes curing and storage of fish, and the packing of cured fish in casks for shipment to St. John's.
[3] Costs for the freighting of fish to St. John's by coastal vessel.
[4] Warehouse storage costs include cartage of fish from vessel to storage, wharfage, cost of storage for a 6-month period, repacking, marking, and preparation of fish for export.

The high cost of operation reduced substantially the total net value of the catch (Table 9). The net value of the half-share, that is,

[24] An allowance of 10 percent is generally used to calculate depreciation. *Farmer's and Fisherman's Guide*, Department of National Revenue, Taxation Division (Ottawa, 1950).

[25] The average annual increase in the Consumer Price Index from 1940 to 1954 is 8 percent. *Canadian Statistical Review, 1955 Supplement*, Supplement No. 2, Dominion Bureau of Statistics (Ottawa, 1955).

TABLE 9.—COMPARISON OF NET RETURNS FOR FISHING UNITS OF DIFFERENT SIZES, IN DOLLARS

Item compared	11 to 12 crewmen	8 to 10 crewmen	5 to 7 crewmen
Size of catch (quintals)	1,200	1,000	700
Gross value of catch[1]	$13,800	$11,500	$8,050
Net value of catch[2]	6,324	4,870	3,074
Net value of half-share	$575 to $527	$609 to $487	$615 to $439
Net cash returns per quintal	$5.27	$4.87	$4.39

[1] This calculation is based on the average price received by the fisherman of $11.50 per quintal. In 1949 the fishermen received $12.25 per quintal for Labrador semi-dry and $11.00 per quintal for ordinary cure.
[2] No allowance is made for a small percentage of spoilage and cullage, nor for insurance and minor charges associated with NAFEL.

the shareman's bonus or wages, was more stable in the larger operating units. The net cash returns per quintal indicated that as more sharemen were added, production increased with better all-around prospects for the sharemen. The tendency to join larger units was in part self-defeating, as larger crew organizations did not guarantee successful voyages. The half-share values represented four to six months of fishery employment. Winter employment for fishermen in Newfoundland was, and still is, difficult to obtain and dependence upon the floater operations resulted in a low or submarginal standard of living. These half-share values did not include extra amounts that were set aside for the trap boat or cook, and thus such values were less again by 5 percent.

In financing the floater crews the merchant expected the half-share from each fisherman to meet the cost of production and to make a reasonable profit. Thus the net cash returns per quintal to the fisherman (Table 9) could be considered by the merchant, under the share system, as indicative of capital earned to offset the costs of production per quintal (Table 8). The difference between these two items determined whether the merchant was able to make a profit on the production end of the operation. In each of the three major units the merchant experienced a deficit of $0.96, $1.76, and $2.71 per quintal; the larger floater unit was the most remunerative, the smallest, the least. To offset this deficit the merchant might hope to make up his losses through the higher prices on the export market.

TABLE 10.—COMPARISON OF THE FISHERY FOR THE DECADES 1931 TO 1940 AND 1941 TO 1950[1]

Item	1931 to 1940 (average)	1941 to 1950 (average)	Percent of decrease
Number of vessels	299	174	72
Gross tonnage	14,500	9,162	58
Number of men	2,344	1,513	55
Annual catch	251,448	123,069	104
Vessel's catch	841	736	14
Fisherman's catch	107	81	32

[1] Statistics provided by the Newfoundland Fisheries Board, St. John's.

The low net income per man shown in Table 9 indicates the high capitalization of the floater units in terms of net returns. It was essentially the ratio of costs to net returns that gradually reduced the number of schooners operating on the Labrador coast.

Declining Trends in Production

The importance of the Labrador floater fishery can be measured in part by its historical continuity over almost two centuries. In the numbers of men and vessels employed and in the proportion of the size of the catch to the total Newfoundland fishery production, the floater codfishery had for a long time been of major economic importance to Newfoundland. The fishery, continuing in operation throughout two world wars and two major trade recessions, had declined to about one-fifth of its size at the beginning of this century. This decline may be illustrated by the relationship the Labrador floater production bore to the total Newfoundland codfishery: in 1940, the floater catch amounted to 22.4 percent; by 1950, the proportion had fallen to 8 percent.

An examination of the floater fishery (Fig. 18 and Table 10) during the period 1931 to 1950 shows a steady decline in the number of men and vessels engaging in the fishery. The average annual catch of the 1941–50 decade was less than one-half that of the previous decade. The decline in the average catch per vessel of 14 percent was matched by a greater reduction in the average catch of 32 percent per fisherman. In the first decade (1930–40), the world-wide economic depression, the decline in the value of sterling, and competition from foreign fish producers, particularly Iceland and Norway, followed by shrinkage of markets for Labrador fish, contributed to the decline of the floater fishery.

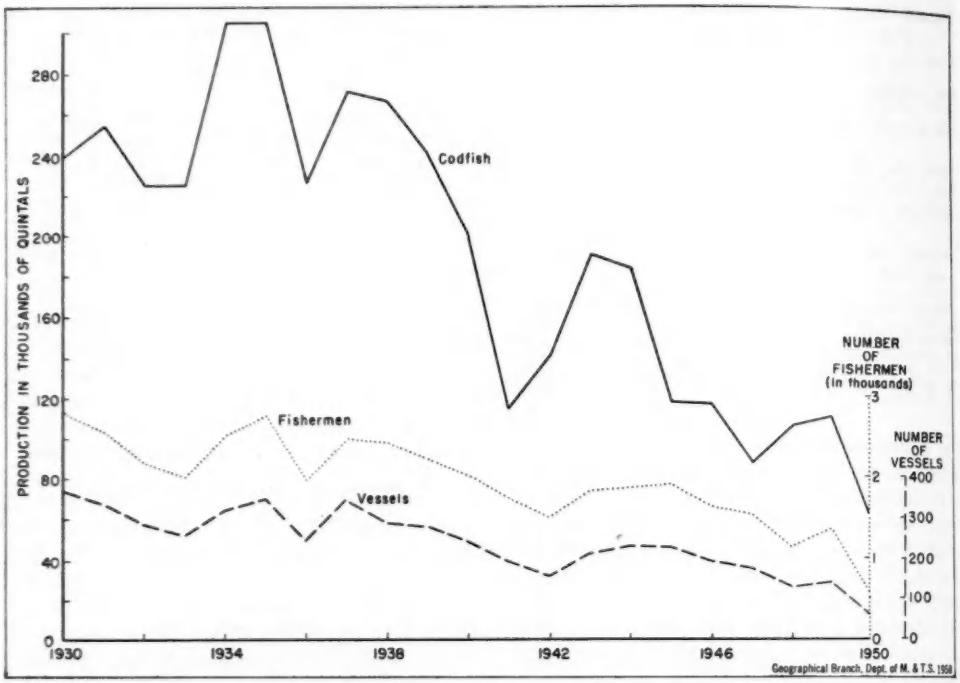

FIG. 18. Trends in the Labrador codfishery 1930–50. Except for occasional seasons of improved activity, the number of vessels and fishermen engaged annually declined steadily. Production followed a similar trend.

In the period immediately following World War II other problems, such as the nonconvertibility of currencies, the development of foreign national fishing fleets, and the increase in the standard of living in areas that formerly were traditional markets for Labrador fish, contributed still further to the decline of the industry.

Sporadic bursts of improved economic activity are evident in the 20-year period. The years 1934–35 and 1937 reflect improving foreign markets for salt codfish. The upward trend evident during World War II resulted from the shipping of the entire Newfoundland production to Great Britain. In 1943 the United Nations Combined Food Board introduced a plan for a world-rationing of salt fish so that the total salt fish production was allocated to the various consuming markets of the United Nations.[26] After the war, marketing of the Newfoundland production of salted codfish was undertaken by the International Emergency Food Council. Inspection of the fish to assure quality, size, and grade was compulsory and was carried out by the Newfoundland Fisheries Board and by the Newfoundland Associated Fish Exporters Limited (NAFEL). Price levels were fixed for each grade of fish; the realized values were four times that of the depression years of 1930–33. However, the discontinuance of the I.E.F.C. in 1947, and the dollar shortage removed the financial support that had bolstered the industry in the immediate postwar period.[27]

The unstable characteristics of production contributed to the decline in the number of vessels operating on the Labrador coast. Dur-

[26] The main allied export producing countries that were brought under the plan were Newfoundland, Iceland, Greenland, The Faroe Islands, and Canada.

[27] Problems associated with the Newfoundland fisheries are found in the following report: *Report of the Commission of Enquiry Investigating the Seafisheries of Newfoundland and Labrador other than the Sealfishery* (St. John's, Newfoundland, 1937).

ing the period from 1930 to 1950 production varied widely. The average annual catch per vessel was 781.6 quintals; the minimum catch was 488.2 quintals (1947), and the maximum catch was 1,051.5 quintals (1950). In terms of individual catches per fisherman, the period of maximum production extended roughly from 1932 to 1939 with average catches exceeding 100 quintals per fisherman. The average minimum catch of 57.4 quintals also occurred in 1947. The average catch for the period amounted to 96.3 quintals per fisherman.

Since confederation with Canada in 1949, Newfoundland has become part of the high-priced dollar area, with its fishing industry demanding higher prices for a low-grade product. In 1950 the product was faced with adverse marketing conditions. The carry-over of salt codfish from the previous year into 1950 reached 15 percent of total Labrador production as a result of international restrictions imposed on the free flow of salt fish, even though the world supply of salt codfish was below the prewar normal. With the fall in prices for Labrador grade product, annual subsidies were established, but these were not announced until the 1950 fishing season was well advanced. As a result, many merchants were discouraged from outfitting the fishermen for the Labrador fishery. The effect of these adverse marketing conditions resulted in the price being established at $7.00 a quintal. The shareman's margin between costs and net returns was almost eliminated. There was virtually no incentive for the shareman to take part in the fishery. Profits, however, were still available for the merchant in the export market, but it was becoming increasingly difficult to recruit sharemen for the fishery. The result was a sharp reduction in the number of floaters operating on the Labrador coast. Beset by increasing operating and maintenance costs, and the continued low prices for the Labrador-style cure, the number of vessels continued to decline to 29 vessels in 1951, to 25 vessels in 1952, and to 5 vessels in 1954.[28] The cumulative effect of unfavorable marketing conditions upon an industry that was submarginal and uneconomic in its operations resulted in the cessation of the floater fishery in 1954, thereby bringing to an end an industry that had been in operation for almost two centuries.

[28] Each year from 1955 to 1958 one floater operated on the Labrador coast. The fish were brought back in bulk and artificially dried; the venture was reported to be economically unsound.

LETTERS AND COMMENTS ON *ANNALS* TOPICS

THE GEOGRAPHY OF COMMUTING

That great geographic differences in the intensity of the daily journey to work are certainly not "illusory" is reflected in the attention given to this matter in recent censuses and in the numerous individual studies of particular lands and cities. What Mr. Chisholm criticizes is the method of dealing with census data—and thereby he also attacks official statistical authorities and other investigators.[1] After consulting with my statistical colleagues, I suggest that his comments are neither relevant nor helpful to the problem in question.

The unit of measure in the countries we have studied is the smallest administrative district, the equivalent of the English parish. There are naturally statistical inadequacies in using data for arbitrary divisions of which everyone is aware. The *Landkreis* in Germany contains an average of some 60 *Gemeinden*, each measuring about 10 sq. kms., and the figures I have used are not (as for the Rural Districts of England and Wales) the movement in and out of the *Kreis* as a unit, but the *aggregate* of movements from all of the *Gemeinden* within it. This is a real measure of intensity of movement. The published map for the 24,000 *Gemeinden* is noted in the article.

We cannot understand the meaning or relevance in this instance of a "weighted average." The difference in average size of the units in the Netherlands and Belgium obviously will explain some of the differences in their percentage of commuting; we are well aware of this and did not press the comparison. In Germany there is a remarkable consistency in the average area of the *Gemeinden* as between one *Land* and another, and Chisholm's comment on "regional contrasts" of size are just not valid.

It is obvious that accurate correlations can only be made "if each worker is asked to reveal either or both the distance and time involved in the daily journey to work." Precisely this information, and much else (age, sex, occupation, etc.), are found in many of the national censuses. This is true, for instance, of the census of the Netherlands, and of North Rhine–Westphalia, and it is upon these data, as well as many individual studies, that our conclusions are based.

It is really quite irrelevant and misleading to talk of the journey to work as based on a "small sample" comparable with the geographic distribution of brain tumors. The latter deals with a minute fraction of a population. Commuting, over large areas, deals with a substantial proportion and even an overwhelming majority of the workers, so that valid correlations could be made between the commuters who reside in a *Gemeinde* and the total number of its resident workers.

Statistical methods are essential in geographic work but they must be properly adapted to the particular geographic problem in hand.

ROBERT E. DICKINSON
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[1] The same methods are used in two recent British studies by R. Lawton, "The Daily Journey to Work in England and Wales," *Town Planning Review*, Vol. XXIX, No. 4 (January, 1959), pp. 241–57, and J. Westergard, "Journey to Work in the London Region," *Town Planning Review*, Vol. XXVIII, No. 1 (April, 1957).

EARNEST AND THE OREPHAGIANS—A FABLE FOR THE INSTRUCTION OF YOUNG GEOGRAPHERS[1]

Once upon a time, not so very long ago, a worthy English gentleman named Earnest Highborne became lost in an oak woods while carrying a vital message to a nearby town. After wandering for two days and two nights he emerged from the forest to behold a splendid country of shining brooks, fertile fields, and neat well-tended villages. The land was unknown to him and not on the map he carried. Yet because of the pleasantness of the country, he set off with a high heart in search of some of its inhabitants. He walked for at least a league before coming to the gates of a good-sized market town. Upon entering the town square he beheld a throng of excited peasant folk and townspeople who had gathered about the steps of an imposing stone edifice. It was evident that matters of consequence were being considered inside.

Presently a blond youth of about twenty years came up to him, bowed, and speaking in a curiously soft and antique English said: "Follow thou me and I shall bring thee safely to the royal chamber. The king hath need of thy counsel." Highborne returned the lad's grave bow and followed him through a narrow alley and up a long stone staircase to a door high on the side of the building. Inside, he found himself in an ornately decorated balcony from which he noted far beneath a meeting of some kind in progress. He turned to see the retreating figure of his guide disappear through the doorway; but before he could call after him, a hush descended upon the assembly.

The king rose: "My liege lords, ladies and gentlemen. The situation which confronts us at this hour is indeed grave, yet only symptomatic of the times in which we live. As the world grows evermore complex, we must cast aside our outmoded ways, grasp new ways for surmounting our difficulties, and bravely face the future." Trembling slightly, his voice fervent but edged with weariness, he continued: "I am a reasonable man. I have never enacted laws that you could not keep. But I shall never waver in my resolve that all our actions be ordered according to universal precept; and my search for these universals will never cease."

"In order to refresh your thoughts on the pressing difficulties of this moment, I now do call upon the Rt. Hon. Secretary, Lord Berkeley, to read the document before us."

Lord Berkeley, tall and of distinguished carriage, rose, cleared his throat, adjusted his spectacles, and began to read in a rich sonorous voice: "Fellow Orephagians, our beloved nation lies beneath the awful scrutiny of an alien power." Highborne's heart leapt to his throat and he began to perspire nervously. The resonant voice continued: "The ambassador of Aresse has informed us of his government's grave displeasure over the state of science in our country. He says that if we do not begin to till our fields and to arrange our comings and goings in accordance with modes prevailing in the more advanced societies, the Aressians may, for our own good, be forced to invade our sacred territory and take over the management of our factories and the cultivation of our fields." Highborne breathed a sigh of relief and edged forward to hear the secretary's next words. "This threat to all that we hold dear must be met by action which is swift and decisive. We have little time. We must gird ourselves for the greatest conflict of our history. With your Lordship's permission, I will call upon General Madison to describe the military arrangements."

General Madison, a rather small man wearing a magnificent Vandyke, rose and, unrolling a map of the country (Fig. 1), proceeded to explain in a quiet, confiding tone the military dispositions and capabilities. Highborne strained to hear what was said and managed to piece together the following: The country of Orephagia is roughly circular in shape. The valleys of two great rivers provide communication to the various parts of the country; all of the great towns are to be found on these two rivers; and it is here that the enemy (which will likely invade by river) must be met and repulsed. The problem is to develop a strategy that takes advantage of natural groupings and mutual proximity of towns, so that meager forces may be used to the great-

[1] Who will want to refer to pages 59–61 in Vol. 50 of the *Annals*, Association of American Geographers.

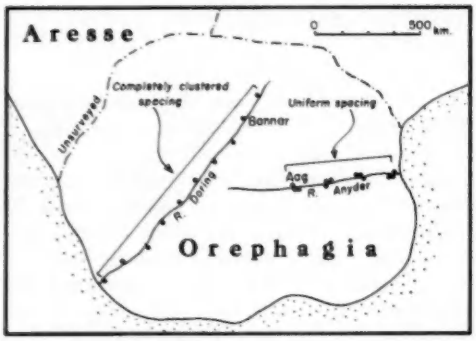

FIG. 1. Location of the great towns of Orephagia.

est advantage. The map shows the locations of the towns, but there is no theory which can guide the formulation of military strategy. Towns which are clustered near one another should elect to fortify one of them, while towns that are uniformly spaced must each take its chances with a small garrison. But how is one to decide which spacing is uniform and which is clustered?

At this point, Highborne noted the blond youth making his way toward the king. They conferred briefly. The king nodded curtly and then stood up. "We have in our midst, this afternoon, a traveller from a foreign land. We have learned that his name is Earnest Highborne and hope that he will be able to assist us in solving this vexatious problem. Highborne, you may speak; scribes, mark well what he says to us."

Caught unawares, Highborne hesitated momentarily and words would not come. Then suddenly a memory suffused his consciousness and he spoke: "Noble sires, I am deeply moved by the honor which you do me at this crucial moment in your history. Perhaps the whole future of your society lies in my advice and how you act upon it. Your problem brings to mind a game our master of mathematics used to have us play when I was a school boy. It was called the 'nearest neighbor' game; and though a game, is based upon our most advanced and elegant statistical concepts. Its beauty and simplicity cannot be challenged. Our scientists have used this technique for studying the spacing of volcanoes along fault lines and ports along seacoasts. If you will accept the irrefutable logic of this measure, you will be able to sleep tonight, secure in the knowledge that your choice has been made with precise objectivity."

"We will arrange the towns on your rivers in two series, and on the basis of the distances which separate them we will calculate the first, second, and third nearest neighbors (Table 1). By determining the number of what we call 'reflexive nearest neighbor pairs,' and comparing the derived values with what we know to be descriptive of clustered, uniform, and random distributions, we can select the proper strategy which will surely save your country."

There was spontaneous and tumultuous applause which the king had great difficulty in bringing under control. When quiet was restored, he summoned the visitor to the assembly floor. Amidst tense whispers Highborne studied General Madison's map, and in a matter of thirty minutes had found the answers. With solemn glee the Rt. Hon. Secretary read the results to the expectant assembly. "The towns on the River Doring are completely clustered. Therefore, the town of Bannar, which has a first and third reflexive neighbor, will be fortified. On the River Anyder, at first appearance the spacing is random, but subsequent analysis has shown it to be uniform. Thus, each town, our own fair city of Aag included, will rely on its local militia for defense. These are the objective findings of science; ignore them and you court disaster." A thunderous roar of approval swelled to the rafters of the great hall. Highborne was lifted to the shoulders of two guardsmen and borne through the enthusiastic throng to regal quarters in the king's palace. Meanwhile, General Madison made all necessary preparations for the anticipated attack.

The Orephagians did not have to wait long. Early on a misty morning three days later the Aressians sailed up the River Doring, occupied the undefended towns, and within thirty-two hours the last outpost had submitted. Tearfully, General Madison signed the surrender documents; and the Aressians appointed Earnest Highborne librarian of the royal archives. Thousands of Aressians arrived in the ensuing years. The shining brooks dried up, the fields withered and turned brown, the houses in the towns fell into disuse and crumbled away. Eventually the entire populace either perished or emigrated to other coun-

TABLE 1.—NEAREST NEIGHBOR ANALYSIS OF TOWN SPACING ALONG THE RIVERS DORING AND ANYDER[1]

Doring River towns	Airline distance (in km.)	Nearest neighbor	Second nearest neighbor	Third nearest neighbor
A				
	100.0	↓	↓	↓
Bannar		↑		
	100.1	↑	↓	↓
C				
	100.2	↑	↓	↓
D				
	100.3	↑	↓	↑
E				
	100.4	↑	↓	↑
F				
	100.5	↑	↓	↑
G				
	100.6	↑	↓	↑
H				
	100.7	↑	↓	↑
I				
	100.8	↑	↓	↑
J				
No. of reflexive nearest neighbors (n = 10)		2	0	2
Observed value		.200	.000	.200
Random value		(.667)	(.444)	(.296)

Anyder River towns	Airline distance (in km.)	Nearest neighbor	Second nearest neighbor	Third nearest neighbor
Aag				
	1	↓	↓	↓
K		↑		
	2	↑	↓	↓
L				
	100			
M				
	1	↓	↓	↓
N		↑		
	2	↑	↓	↓
O				
	100			↓
P				
	2	↓	↑	↑
Q				
	1	↓	↓	↑
R		↑		
	100			↓
S				
	2	↓	↑	↑
T				
	1	↓	↓	↑
U		↑		
No of reflexive nearest neighbors (n = 12)		8	8	6
Observed value		.667	.667	.500
Random value		(.667)	(.444)	(.296)

Values lower than random indicate clustered spacing; the lower the value the greater the clustering. Values higher than random indicate uniformity of spacing; the higher the value the more uniform the spacing.

[1] The spacing of towns along the River Doring is shown to be completely clustered according to nearest neighbor analysis, while the spacing of towns on the River Anyder is, though random for the nearest neighbor, more uniform than random for the second and third nearest neighbors.

tries. A team of archeologists rummaging through the site of Aag in 1971 came upon this cryptic note written in chalk on a fragment of slate:

$$1^{P}n=(2/3)^{n}$$

which is, being interpreted: You can fool too many people, too much of the time, in too many places.

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ABSTRACTS OF PAPERS PRESENTED AT THE 56TH ANNUAL MEETING OF THE ASSOCIATION OF AMERICAN GEOGRAPHERS, DALLAS, TEXAS, APRIL 17–21, 1960

SYED REZA AHSAN—*Worthington: A Sample Study of Land Use in Santa Fe Valley, Florida*

Worthington is located in Union County, Florida, midway in the Santa Fe Valley. The area was settled more than a century ago and has been mainly agricultural. Agricultural land use has changed considerably since the early settlement. Lowlands are still forested and some of the areas cleared for agricultural purposes have gone into pasture.

Main agricultural crops are various types of truck crops, tobacco, and corn. The area lies in the transition belt between north and south Florida and is the northern limit of truck-crop farming.

No topographic map of this area is available. Land use has been plotted on maps based on aerial photographs made in 1938 and 1950 and recent 35mm color slides taken from a small plane. Various types of land use have been brought out on the basis of intensive field work in the area in addition to the photographic interpretation. Changes are discussed on the basis of the three land-use maps. Climate, soils, and transportation are important controlling factors in the land use of this area. Worthington lies in a zone of 260 frost-free days. Still the hazard of low temperatures during winter months is considerable, which explains the absence of citrus in this area. The Hawthorn formation is exposed here at various places and forms the basis of soils. Transporation is important from the point of vegetable crops.

Comparative studies with other areas in the valley show variations in land use.

JOHN W. ALEXANDER AND JAMES LINDBERG—*Measurements of Manufacturing: Coefficients of Correlation*

For years geographers have speculated as to the best criterion for measuring the distribution of manufacturing. Of the several absolute measurements, which gives the most meaningful picture: number of establishments, number of production workers, number of employees, value added, etc.?

The research reported in this paper proceeded on the premise that the above question could be answered more intelligently if geographers had a scientific measurement of the degree to which the several absolute measurements vary from place to place.

Accordingly, the United States was taken as a case study, and the 1954 *Census of Manufactures* was chosen as the data source for making a statistical analysis of the variation of thirteen absolute measurements as they varied among 2,146 areal units (166 Standard Metropolitan Areas plus 1,980 counties). In addition to these 2,146 areal units there were 45 counties having no manufacturing and 766 counties for which the census did not give complete data on manufacturing. These 811 counties were omitted from the study. Thus, the conclusions are based on a 73 percent sample of the 2,957 possible areal units.

Punch cards were punched to carry each of the thirteen measurements for each of the 2,146 areal units. The cards were processed on an IBM 650 Computer which computed coefficients of correlation according to the Pearson formula. This equipment and direction for operating it were provided through the courtesy of the University of Wisconsin Numerical Analysis Laboratory.

The resulting coefficients of correlation between the thirteen variables show such high correlation between criteria numbered 2, 3, 4, 5, 6, 7, 8, 9, 10, and 13 that for purposes of viewing over-all distribution of manufacturing in the United States as a whole, it makes little difference which of these criteria the geographer selects—insofar as measuring manufacturing in terms of a single variable as of 1954 is concerned.

ROBERT L. ANSTEY—*The Geographic Work of Lewis Evans*

Although usually considered an outstanding early American cartographer, Lewis Evans (1700?–1756) is seen as the leading geographer in the Middle British Colonies of America in the first half of the eighteenth century. His regional analyses of New York, Pennsyl-

vania, New Jersey, and Delaware represent a marked departure from the incomplete and sometimes fanciful traveler's reports which characterize much of the secondary and even some of the so-called primary source materials on the geography of that period.

Like modern geographers, Evans included summary information on climate, soils, vegetation, lithology, land use, and cultural features. He discussed the production of the more important minerals and assessed the potential capability of the local economy as he saw it. He described the boundaries of the colonies in a period when this information was difficult to obtain and almost impossible to demark. His works were based on both field study and library research and analysis, as done today. Published just prior to the Revolutionary War and the great westward migration, his works were in great demand and had considerable influence. Twenty years after his death his *Analysis* was republished with only minor changes, and 70 years after his death a pirated copy of his map was again published, disguised as a fresh contribution.

Only part of Evans' geographic work has been uncovered in spite of current research efforts. A revised list of Evans' known works is given, updating the information on this early geographer and at the same time augmenting the catalog of source materials on the history of geography in the United States.

WILLIAM APPLEBAUM—*Teaching Marketing Geography by the Case Method*

Current methods in teaching geography embrace lectures, laboratory instruction, field trips, report writing, and seminars. The case method is currently not used in teaching geography. In the teaching of law, medicine, and business administration, the case method has proved to be an effective and valuable tool.

Problems in marketing geography lend themselves to case-method teaching at the graduate level. Each case presents a concrete situation as it exists and faces a specific business, industry, or region. The basic issues are stated and relevant data are reported carefully and accurately. The students study this material analytically with the view of arriving at a decision as to what action might be taken to meet the problems involved in the situation. These problem-solving exercises should prove especially valuable for training applied geographers.

In teaching by the case method, the instructor does not lecture. The burden of the discussion rests upon the students. The instructor only helps stimulate and guide the discussion.

I have developed and used a number of cases, which involve marketing geography problems, in my teaching of food distribution at the Harvard Business School. It is this experience that leads to the suggestion presented here.

A brief case dealing with problems of strategy in store location is offered as an illustration.

CHARLES W. ARNADE—*Cattle in Spanish Florida 1513–1763*

The traditional historical writings on Spanish Florida state that local or regional food production was low or totally absent. It is said that the military garrison of St. Augustine, which included over 90 percent of Florida's European population, was supplied from Cuba and Mexico. The absence of the *encomienda* and *repartimiento* in Florida tended to confirm this.

Recent research into Spanish documents dealing with Florida reveal that there was noticeable local and regional food production, especially the breeding of cattle. I have found a list dated December 1700, of ranch owners who were members of the St. Augustine garrison and who owned large *haciendas*. They supplied meat to the army.

These *haciendas* were located: (1) along the St. Johns River in the vicinity of today's Palatka; (2) in today's Alachua County with today's Gainesville at its center; (3) in Apalache with Tallahassee as the focal point. Four rivers, the St. Johns, Suwanee, Santa Fe, and St. Marks, assured proper transportation and provided possibilities for contraband. Apparently the *haciendas* along the St. Johns River were small but those of Alachua and Apalache quite large. The largest *hacienda* was *la Chua* on the Suwanee and Santa Fe rivers.

Many questions remain unanswered as documentary material on cattle is widely dispersed. The following aspects remain unclear: (1) Who brought cattle to Spanish Florida? (2) When were these *haciendas* es-

tablished? (3) General information about the Apalache *haciendas*. (4) Were these *haciendas* effective in reducing the outside meat supply? (5) Did they produce anything else besides cattle?

JOHN P. AUGELLI—*Functions of the "Agricultural Colony" in the Dominican Republic*

The Dominican Republic is experimenting with agricultural colonization in an effort to achieve several objectives, such as (1) bolstering her frontier against the growing pressure of Haitian population and "Dominicanizing" the border population which had been under strong Haitian cultural influence; (2) attracting immigrants from abroad; (3) populating "empty areas" by resettling surplus population from both urban slums and overcrowded farm zones; (4) controlling an artificial country-to-town movement which would create urban slums and deprive rural areas of labor. Agricultural colonies vary not only in purpose but in ethnic composition, degree of government aid given, the amount of land per colonist, the quality of land, and in numerous other respects.

It is the purpose of this paper to evaluate the special functions of the agricultural colony in the light of the Dominican objectives. Particular attention will be given to questions of settlement stability, comparison of types, and the possible lessons derived from the Dominican experiment for possible application elsewhere.

THOMAS FRANK BARTON—*Thailand's Annual Rainfall by Geographic Regions*

The common practice of dividing Thailand into the four geographic regions of Central, Northern, Northeastern, and Southern contributes to false descriptions and interpretations of its annual rainfall distribution and its geography. Contrary to numerous published reports, the Northeastern region with 57 inches receives more annual rainfall than the Northern with 51 inches or the Central with 50. To correct another misconception, Southern Thailand does not receive more rainfall than the other geographic regions. Southeastern Thailand receives 96 inches whereas Southern Thailand gets only 84 inches.

One of the most important reasons for these past misconceptions is the fact that the changwats of Southeastern Thailand were classified as part of the Central region. Since the heaviest rainfall comes in the Southeastern region, when one averages the rainfall here with that of Central Thailand the amount of the latter region increases so that it becomes higher than the averages of Northeastern and Northern Thailand.

Inaccurate characterizations of geographic regions continue to handicap geographic engineering. Thai government officials and foreign advisors for decades have failed to recognize that agriculture in the Northeast is not limited so much by the amount of rainfall as by its erratic distribution and the failure to effect better utilization.

Recognizing the two basic facts—(1) that Northeastern Thailand receives more rainfall than the Northern or Central parts and (2) that the Southeastern region gets more than the Southern—the government is making changes in its national planning.

It is suggested that geographers recognize and use six geographic regions, namely, Central, Northern, Northeastern, Southeastern, Southern, and Western Southwestern.

F. H. BAUER—*A Few Went North: Factors in the White Settlement of Northern Australia*

In their 136-year struggle to establish permanent and economically successful occupation of northern Australia, Europeans have been constantly confronted by three persistent problems: distance, a markedly seasonal climate, and ignorance. Simple geographical isolation caused the failure of the first military settlements and later laid untold danger, labor, and expense upon the governments, companies, and individuals whose efforts have even yet achieved only moderate success. These difficulties were compounded and new ones posted by a climatic regime which fostered recalcitrant soils and vegetation, while yielding little rain for months, or even years, and then deluging the parched country with floods which caused loss of life and property and made overland transport an impossibility. Admittedly unaware of the nature of the country and climate at the outset, the white man has maintained a colossal ignorance of it almost to the present; even more damning, he

has frequently exhibited a reprehensible refusal to learn by experience.

World War II necessitated some improvement in communication and transportation. This work has been slowly extended, thanks to machinery which makes such undertakings possible with a small, largely unskilled, labor force. Of at least equal importance is the postwar attack upon many fronts by men and agencies who are, at last, asking the questions "where," "why," and "how." While no revolution is in the making, the white man is laboriously learning what the black fellow knew centuries ago—how to live in northern Australia.

CHARLES F. BENNETT, JR.—*Cultural Zoogeography: An Inviting Field of Research for Geographers*

Although animal geography is recognized by many geographers as being an essential part of their discipline, there has been relatively little work done in this aspect of geography by geographers. This paucity of zoogeographic work by geographers may stem from a conviction that only zoologists are equipped to undertake such research.

However, a broad and potentially rewarding area of investigation which might be designated as cultural zoogeography awaits the attention of geographers who possess a relatively modest background in biology or zoology.

Cultural zoogeography may be defined as that aspect of geography which accumulates and systematizes data relating to the many points at which there are and have been interactions between animals and human cultural activities. Examples of some research topics which would fall under the above definition include: the investigation of man as a deliberate or accidental agent in the dispersal of animals; regional patterns in the distribution of domesticated animals and their history of introduction and dispersal into new areas; regional patterns in pet keeping; regional patterns in hunting and fishing; animal caused or carried disease as a factor in human occupance of areas.

A vigorous tilling of this area of geography should result ultimately in a more widespread appreciation by geographers of the importance of animals as an element in the landscape as well as providing new insights into man's present and past ecological relationships with his physical and biological environments.

JOHN F. BERGMANN—*The Antiquity of Cacao in the Americas*

The center of origin of cacao is still uncertain. The hypothesis on this subject by the British botanist E. E. Cheesman (1944) that cacao originated along the eastern base of the Andes Mountains near the Ecuador-Colombia border and thence spread across the cordillera to Central America, now seems unacceptable in view of recent botanical evidence that all families of the modern angiosperms—and therefore *Theobroma*—had evolved by the middle Cretaceous, a period prior to the uplift of the modern Andes. Instead, we may infer a very extensive tropical distribution of *Theobroma* in the Americas following its origin, and further, that the paleographical center of origin of *Theobroma* may possibly have been in a region that is now below sea level. The Andean separation of cacaco types was subsequent to the origin of cacao.

A mold-made effigy whistle of a cacao goddess found near Tajumulco, Guatemala, is the oldest known artifact relating to domesticated cacao. This figurine, dated at around 900 A. D., testifies to an ancient esteem and utilization of cacao in the Maya area of Central America-Mexico, and is important evidence in establishing this area as the center of domestication of cacao. Utilization of cacao by pre-Columbian peoples of South America is conspicuously absent from the record. Cacao cultivation in the Maya area may be projected back in time at least to the beginning of the Christian Era, and possibly much earlier.

JACQUELYN L. BEYER—*Geographic Contributions to Precision in Resource Planning*

The United States is faced with an increasing need to examine the methods used for the fullest development of its natural and human resources. The geographer has particular skills which need to be utilized in any such examination. This paper will outline a survey of the work of one federal agency in one particular area of resources management. Such an examination will help to clarify those points

where geographic contributions can be made in future planning by that agency.

The system used here is to examine the "hierarchy of assumptions" upon which rests the development programs of the Bureau of Reclamation in the western states, to note how this hierarchy has been reinforced by application of policy, and the implications of such an analysis for a geographic consideration of resources development programs in western states.

The broad base of this hierarchy is clearly the assumption that development, whether of a single-purpose project or of multiple-purpose basin-wide programming, is (1) necessary, (2) desirable, and (3) possible. If the basic assumption is upheld, or at least accepted, then the problem becomes one of the methods used over time to determine whether a given project is necessary, desirable, and possible, and how the various methods of determining these three phases relate to each other. The final analysis would show the flaws in the methods and suggest ways to insure that more precise methods can be initiated.

LLOYD D. BLACK—*Metropolitan Area and City Size Patterns of Manufacturing Industries: 1954*

This paper analyzes the distribution of manufacturing employment by city size and standard metropolitan area location and identifies those industries tending to concentrate in larger cities as well as those that locate in smaller towns and rural areas.

Seventy-four of the 446 individual industries in the Standard Industrial Classification have more than half their employment outside metropolitan areas (e.g., seamless hosiery, poultry dressing plants, primary aluminum, and synthetic fibers). Examples of industries tending to concentrate in cities of over 100,000 population are machine tools, luggage, fur goods, prepared meats, and macaroni.

A wide range of city-size preference is shown within major industry groups. For example, work shirt employment is mostly outside large centers of population, whereas the women's suit industry is 91.9 percent inside SMA's.

The paper is based upon information contained in *Metropolitan Area and City Size Patterns of Manufacturing Industries: 1954*, a special tabulation of the 1954 *Census of Manufactures* prepared by the Office of Area Development, Business and Defense Services Administration, U. S. Department of Commerce. This report makes available hitherto unpublished data on plant size, employment, earnings, and value added by manufacture, by city size and metropolitan area status.

When similar tabulations from the 1958 *Census of Manufactures* become available (probably in 1961), it will be possible to show the trends in city-size preferences by individual industry for the 1954–58 period. Presumably these trends will reveal shifts of manufacturing employment from metropolitan areas to non-metropolitan areas and from larger to smaller centers of population.

JAMES M. BLAUT—*Jamaican Farming Systems in Nicaragua, Costa Rica, and Panamá*

Along the Caribbean coast of Nicaragua, Costa Rica, and Panamá, first and second generation Jamaican immigrants make up a sizeable proportion of the total population. This is, on the whole, a sparsely settled area with abundant free land. Jamaicans arrived during the era of railroad and canal building, and later during the prosperous period of banana planting, between the 1880's and 1920's. Employment opportunities declined after 1930, and most Jamaicans returned to their traditional occupation of smallholder agriculture. In view of the sharp contrast in land availability between Jamaica and the Central American area of settlement, the question as to what farming systems were selected in the latter area has implications for the more general problem of the relation between land availability and farming systems in tropical lowlands, and thus for the problem of overpopulation in regions of this character. The research reported in this paper sought to answer this question and to discover the reasons why certain farming systems were chosen over others.

Initially, most Jamaicans adopted shifting agriculture, except where a market for bananas was regular and accessible, because food crop production under this system, and with abundant land, provided higher returns per increment of labor than does the sedentary dry-field system characteristic of Jamaica.

Later, tree crops replaced shifting agriculture, in response to increased demand for cacao and for other reasons. Significantly, those few areas showing land shortage are the only localities where ground-crop-oriented sedentary dry-field agriculture prevails.

CLYDE J. BOLLINGER—*The Sun-Tide Origin of Climatic Cycles*

Ancient scholars in Babylonia and Greece, including the great astronomer-geographer Claudius Ptolemy, believed that the weather was influenced by the configuration of the planets and that if all of the planets came into alignment with the sun, extreme weather would result. This idea was considered by Ptolemy and by his successors to be a part of astrology and was not developed by science as a part of the Revival of Learning. In the modern period astronomic attention has tended to focus on the stars and outer space while meteorologic attention has been directed toward atmospheric processes and daily weather forecasting rather than climatic cycles and the primary causes of climatic change.

The astronomers, however, have discovered variable stars, and that the so-called "Solar Constant of Radiation" is a misnomer, and meterologists have found that weather changes cannot be explained solely on the basis of terrestrial antecedents.

Sun-tide theory discloses that climatic variations are inherent in the asymmetrical nature of our solar system. Jupiter, Neptune, Mercury, Saturn, and Earth all have eccentric orbits and are in perihelion in the same heliocentric quadrant, between the perihelion of Jupiter, 13° 34′ 53.5″, and Earth, 102° 08′ 57.5″, thus causing exceptionally strong suntides ("spring tides") when they are grouped in this quadrant. Spring tides, it now appears, are accompanied by a shift to shorter radiation wave lengths and abnormally high solar radiation. The calculated sun-tide resultant of the major planets thus provides a theoretical basis for climatic cycle analysis and numerical weather forecasting. Sun-tide fluctuations in the period 1930–59 will be analyzed.

RONALD R. BOYCE—*Measurements of Urban Retail Affinity: A Further Application of Linkage Analysis*

Despite obvious spatial regularities in the internal arrangement of retail clusters, no rigorous empirical measurements of retail spatial affinity have been advanced. Linkage analysis is believed by the authors to provide a necessary sophisticated tool for revealing and explaining much of the apparent spatial order in such clusters. This technique makes available a measure of which businesses desire to locate adjacent to other businesses. It also provides a means of combining these adjacency desires into affinity groups. Affinity groups can readily be presented on map-like diagrams.

A field survey of several shopping districts in Seattle and Bellingham, Washington, was used in order to determine the business adjacency data, and over fifty shoppers were followed from store to store in downtown Bellingham in order to gather shopper information. From these data composite adjacency matrices and "incremental distance" matrices were computed between each business type and all others. Linkage analysis was then applied.

From the field work, the empirical desires of business types to locate next to one another and in particular cluster groups was determined by linkage analysis. The group and cluster patterns which would emerge if shoppers alone determined the spatial arrangement of retail business is also presented. These two desire patterns are then compared and analyzed.

Especially strong business and shopper spatial affinity linkages were found between apparel stores, apparel stores and shoe stores, department stores and variety stores, automobile accessory stores and automobile garages, and furniture stores and used book stores. These linkages form ten major cluster groups. The spatial grouping patterns between business affinities and shopper affinities were highly correlated. Nevertheless, business affinities and shopper affinities are characterized by reciprocal relationships.

DONALD D. BRAND—*The Early History of the Range Cattle Industry in Northern Mexico*

Range cattle and techniques were taken from Spain to the Antilles and thence—1521—to the Veracruz lowlands and such highland valleys as Mexico and Toluca. Missionaries and cattlemen soon stocked the plains from

Queretaro to Guadalajara. Here huge herds were ranging before the development of markets at mines, such as Zacatecas (1546–48). This range in Michoacan and Nueva Galicia was the reservoir whence cattle went northwestward into the Pacific lands and northward into Nueva Vizcaya (Durango, Chihuahua, Coahuila, etc.). Then the *estancias* of Nueva Vizcaya supplied the ordinary cattle and the black cattle that stocked New Mexico (1598) and Texas (1682–90.) Only the missions had large herds in the early Spanish period in New Mexico, Arizona, Texas, and California.

Cattle raising was a source of food and goods and was a way of life. It moved with the frontier—with missionary, miner, soldier, and farmer. Sometimes cattle raising was initiated because of markets provided by mines but more often it developed as an accompaniment of the *latifundios*. Because of lack of manufacturing and other opportunities for investment, wealthy officials, miners, and churchmen invested in land. Through purchase and grant the largest estates in New Spain developed in northern Mexico—such as the Marquesado de San Miguel de Aguayo. A later manifestation was the Terrazas *latifundio,* the largest in Mexico, which branded 140,000 calves annually.

The cattle and techniques were Spanish and Mexican until the period 1880–1910 when the Hereford, the windmill, and barbed wire came over the border.

JAMES E. BROOKS—*Problems of a Riverine Port: Portland, Oregon*

The port of Portland, Oregon, which usually ranks fourth in total waterborne commerce and first in dry cargo tonnages on the Pacific Coast, is faced with many problems critical to its future: (1) The 110-mile ship channel from the mouth of the Columbia River, which is 35 feet deep and 500 feet wide, is proving to be too small as ships of the world fleet, especially single-purpose carriers, increase in size. (2) Bulk commodities, mainly petroleum products, grain, lumber, and mineral concentrates, dominate the trade, and relatively few passengers and little general cargo are handled, limiting the attractions of the port for many shipping lines. General cargoes have been almost erased from coastwide trade in recent years because of competition from railroads and trucking companies and the desire of industry to reduce inventories of raw materials and finished products by using fast freight. (3) Since World War II, several trans-Pacific steamship lines have made Portland neither the first nor the last port of call, which puts the port at some disadvantage for shipping. (4) Few products moving by waterborne commerce are actually processed at Portland; the city serves largely as a collection and distribution point. Further, waterfront activities fluctuate with seasonal shipments of agricultural products and irregular shipments of commodities that rely on U. S. Government aid to foreign countries. (5) Ship construction and repair flourish only during wartime.

Promotion of industrial development and processing, harbor improvements including equipment modernization, Columbia River navigation improvements, and traffic solicitation seem necessary for the future of the port.

ROBERT HAROLD BROWN—*Some Sequential Occupance Time-Lines of Minnesota*

In the search to discover methods for expressing dynamic occupance more accurately and completely, the utilization of historic time-lines, in combination with maps in series plus notations concerning types of activities or establishments and culture items or processes, seems to possess latent possibilities. Such sequential occupance time-lines provide a suitable arrangement to indicate many phases of spatial uniformity, areal organization, and culture origin and spread. They may also be useful as a research tool in the definition of significant geographic-historic eras.

This study attempts to illustrate the foregoing ideas through the use of five examples. The first three examples show the occupance down through time of a farm in central Minnesota, an establishment in the city of St. Cloud, and a broad view of the city of St. Cloud, Minnesota. A feature of the last named example is a crude endeavor to picture an areal-functional pattern in four space-time dimensions. These three samples were examined by field study methods. One of the remaining two examples is concerned with the progress of agriculture in Minnesota, while the other presents a generalized view of past and present occupance for the entire state of Minnesota. Statistical analysis and less objec-

tive methods were used in obtaining results for these two samples. Each of the five sequential occupance time-lines indicates from four to six developmental stages. Difficulties encountered in separating stages sometimes necessitated the use of transition-period symbols between eras. A many-fold increase in the samples examined by field study methods might very well produce a more dynamic and more accurate view of the two examples studied by other methods.

S. EARL BROWN—*Some Community Relations of the Ohio Valley's New Aluminum Companies*

With the recent move of three primary aluminum plants into the Ohio Valley, a number of community relation problems have developed. The extent of these problems varies with the specific location of each of the units, that which is most isolated being forced into the more active role.

The Kaiser plant near Ravenswood, West Virginia, has been faced with the most critical housing and educational facility problems. Since there are few towns in the immediate vicinity, Kaiser has sponsored housing development and the line between "Old Ravenswood" and "Kaiser Ravenswood" is distinct. Several trailer courts provide additional housing. The population influx stimulated the company to build the school which taxes could not immediately provide.

Less isolated is the Ormet plant at Hannibal, Ohio. A number of towns provide housing possibilities, even though those in West Virginia require the use of ferry service. Although not sponsored directly by the company, two towns contain community developments housing plant employees. One of these developments has had considerable difficulty and its continued existence is questionable.

Finally, the Alcoa operation near Newburgh, Indiana, while not yet completed, anticipates no such repercussions. It is assumed that nearby Evansville will supply much of the labor needed without major housing development. Evansville is a labor surplus area and has been so for some time. Additional labor can easily be drawn from Henderson and Owensboro, Kentucky, as well as from smaller communities in southern Indiana.

L. T. BURCHAM—*Cattle Ranching in California —1770 to 1880*

Ranching, the first industry in California, had its beginning with the arrival of cattle and horses at San Diego in 1769. The period from this beginning until range lands were fully occupied embraced one hundred and ten years—1770 to 1880.

The Spanish pioneers found a magnificent range resource, differing significantly—in forage cover, precipitation patterns, and ecological characteristics—from any other region of North America. An abundance of nutritious forage was adapted to year-long grazing under proper management. The forage crop, totaling 22.3 million animal unit months annually for Spanish livestock, would have supported about 1.8 million animal units of modern stock on a sustained basis.

At least four significant phases in ranching can be distinguished as California developed from a frontier outpost of New Spain to a vigorous new member of the United States. During Spanish and Mexican phases the range livestock industry dominated economic and social life of the province. Discovery of gold brought commercialization of ranching, the spectacular livestock boom of the 1850's, and overstocked ranges; this phase was terminated by devastating droughts in the 1860's, permanently curbing livestock raising on a speculative basis in California.

The seeming disasters of the 1860's had beneficial aspects: the importance of sound economic bases for ranch operation was demonstrated; foundations of proper range management were laid. As intensive agriculture pre-empted adaptable coastal and valley lands, ranching gradually moved to more remote areas. By 1880 it was said: "No available pasturage in excess of occupied pasture."

IAN BURTON—*Factors Affecting the Agricultural Occupance of Flood Plains in the United States*

An analysis is made of the elements of the flood hazard considered significant for agricultural occupance, as a basis for a classification of flood plains. Fifteen of these elements are considered from three points of view.

First, on the basis of stated assumptions, tentative models of the ways in which occu-

pance may be expected to vary with respect to the fifteen elements of the flood hazard are developed. Second, an examination of the literature and interviews with experienced field workers suggest modifications of the hypothetical relationships described, and indicate the importance of some of the elements and the relative insignificance of others. The lack of precise knowledge concerning the relationship of these elements with each other is demonstrated. Thirdly, data from surveys in four widely different plain situations provide the basis for a comparison of the results of three approaches.

This exploratory investigation suggests that five of the elements (width and slope of flood plain, frequency and seasonality of flooding, and the size of the drainage area), may be combined into a refined model, which will be tested in a more detailed examination of recent changes in agricultural occupance.

ALLEN D. BUSHONG—*Mennonite Settlement in British Honduras*

The colony of British Honduras is the most recent Mennonite settlement in the western hemisphere. Colonists from the state of Chihuahua in northern Mexico formed three parent settlements in the low-lying northern half of British Honduras in 1958. A fourth settlement was made in 1959 in the extreme southwest corner of the colony. The present Mennonite population in British Honduras numbers 1,700. The British colonial government gave the Mennonites a high degree of autonomy, allowing them to practice their religion and to run their communities on a largely self-contained basis. The government further made technical and financial aid readily available to the Mennonites. The Mennonites cleared the land by setting fire to the vegetation, in the manner of the native cultivators. *Milpas* of corn and rice were planted initially. Pasture grasses are now being seeded and varieties of citrus are being laid out. It is the intention of the Mennonites to concentrate eventually on dairying and associated enterprises and to develop this much-needed industry in the colony. British Honduras greatly desires agricultural colonists such as the Mennonites in order to build up the heretofore largely neglected agricultural phase of the colony's economy.

KARL W. BUTZER—*Geomorphological Evolution during the Pleistocene of Mallorca, Spain*

This preliminary report is based on field work carried out in the upland plains of southern and southwestern Mallorca during the summer of 1959. Purpose of this study was to analyze the effects and interactions of increased cold climate weathering during the glacial phases, and of moister climate during what were obviously local pluvial phases. As a basis of relative correlation the morphological evolution of the coastline in the Santañy area was studied in detail. This enabled a correlation of continental deposits to high interglacial strandlines, the second oldest of which (elevation 22–23 m.) contains a Tyrrhenian fauna. Of particular interest are regressional dunes of last, and possibly also penultimate, glacial age. The pronounced foreset bedding indicates remarkably uniform wind directions differing in no way from the dominant, local wind direction of today. Intercalated with these coastal dunes are widespread earthflow deposits or "blockstreams" with a limestone breccia and a rendzina-like terra rossa. On the basis of gravel and soil analyses it is possible to describe a range of transition between piedmont alluvial fans or plateau gravel sheets (with fluviatile rolled gravels: $\frac{2r}{L}$ ranging from 125 to 300) and local breccia-like deposits ($\frac{2r}{L}$ from 0 to 100), each a product of a considerably moister climate corresponding to regressions of the Mediterranean Sea.

Although there is evidence of frost-fractured pebbles in some near sea-level exposures, the dominant Pleistocene agent of process was accelerated fluviatile erosion and deposition, often grading over imperceptibly into mass movements—depending upon the local topography. So far no evidence of cold climate solifluction could be identified.

ALBERT S. CARLSON—*Will the Woolen and Worsted Factories of New England Follow the Cotton Textile Industry to the South?*

The recent decline of the woolen and worsted industry in New England and the gains in the South have business leaders and economic geographers in both areas searching for causes

and guessing what will be the future areal geography pattern of the industry.

Factually, we know that even though 45 percent of the wool spindles and 65 percent of the worsted spindles have been liquidated in New England since 1949, the area still employs 40,000 workers in 170 mills. In 1950, the South's share in woolen and worsted, 6–7 percent of total output, was about equal to its position in cotton textiles in 1890. Since 1939, major plants have been built in the South; the number of woolen plants in the Piedmont increased from 21 in 1939 to 29 in 1950, while worsted plants numbered seven in 1939 and 29 in 1950. Twenty-five of these are branch plants of New England concerns.

New England in 1960 continues to produce one half of the woolens and worsteds for the nation. What of the future? The answer to this question involves such varied factors as significance of location to the Boston wool market and banks, to the New York garment industries, and a possible added future advantage of New England plants resulting from the increased technological problems of mixing wool with synthetic fibers.

Case histories of several successful New England plants illustrate regional advantages and maps show the location of plants now operating and factories liquidated in recent years.

HANS CAROL—*Field Training for Graduate Students*

A student receives most of his training indirectly from professors and by literature. He comes in direct contact with geographic reality only in his field training. Here he gets the chance to transfer reality into intellectual concepts; here he observes correlations and practices the first steps of generalization. In order to achieve a complex geographic understanding the study area should be small. Studies in large scales, as developed by Midwestern geographers and applied practically in the TVA and Puerto Rico surveys, were a great step forward in geography.

In the light of the above, ten years of field training at Zurich University, and two field camps at Clark University, the author's experience can be summed up as follows:

1. Field training is valuable in all parts of geography. Agricultural geography is particularly well suited to study man's adaptation to cultural and natural conditions. In this field a selected team area, representing a geographic object (a geomer), is seen from the viewpoint of its agricultural usefulness. Thus an evaluation of phenomena and processes can be achieved.

2. Analytical procedure is based on air photos and the use of overlays: (a) land use map; (b) evaluation of the agro-physical factors (slope, soil, etc.) and mapping of complex Agro-Physical Land Units (APLU); (c) classification of APLU's according to Land Capability Classes; (d) farm interviews—farm map. This systematic analysis promotes understanding of the complex land use pattern.

3. Writing the field report provides training in conveying all facts and findings in an organized way to the reader.

DOUGLAS B. CARTER—*Agricultural systems and Expectable Drought in Mexico*

A method of estimating expectable drought is provided by Thornthwaite's concept of mean annual water deficit, modified according to recent ideas of soil moisture availability. A map of mean annual water deficit, based on the data of more than 200 climatological stations in Mexico, is presented. The interpolation method adopted in preparing the map is entirely dependent on climatic data and topographic controls. Consequently, the map may be compared to agricultural patterns without the prejudice of vegetation or agricultural features having been a factor in interpolation.

A consistent correspondence between mapped values of water deficit and crop patterns in Mexico exists. The conclusion is reached that water deficit is a limiting factor in the agricultural systems of Mexico when specified amounts of deficit are exceeded. The seasonal variation of crop requirements and moisture shortages further illustrates the nature of the harmony between crop types and water deficit regions in Mexico.

KUEI-SHENG CHANG—*The Changing Railroad Pattern in Mainland China*

Railroad construction is an item of great economic and strategic significance in the Chinese communist programs of development. Extensions of pre-existing lines as well as com-

pletions of new ones have created a network still largely unfamiliar to the outisde world. Several trunk lines now link the hitherto relatively inaccessible areas in northwestern and southwestern China with the more developed eastern regions. For example, the Lanchow-Sinkiang line has already reached the foothills of the Tien Shan, and is scheduled to join the Soviet Trans-Turkestan Railway at Aktogay during the coming year. The Paotow-Lanchow line which has just been completed links Inner Mongolia directly with western China. The Trans-Mongolian Railway now serves to shorten by two days the journey from Peiping to Moscow. Since the completion of the Paochi-Chengtu and the Chengtu-Chungking lines, southwestern China has been re-oriented in its economic relations with the Yangtze Valley, and under construction are three branches extending from Szechwan to Yunnan and Kweichow. In the remote interior, a line is presently being built from Lanchow to the Tsaidam Basin. And in the east, the Yingtan-Amoy line which was designed to connect the coastal deltas with the central Yangtze Basin will be extended to Meihsien in Kwangtung Province.

The purpose of this paper is to analyze the changing pattern of railroads in mainland China, particularly in relation to the exploitation of resources, the redistribution of population, and other political and strategic aims and consequences.

T. K. CHANG—*Exploitation of the Sandals*

Sandals are shrubs representing several species of *Santalum* distributed in Eastern Malaysia, India, Australia, and the Pacific Islands, all producing aromatic heartwood called sandalwood, which is used chiefly for religious purposes in the Orient. The great demand for it in earlier times led to a profitable trade supported by a reckless destructive exploitation of the sandals in eastern Malaysia and the Hawaiian Islands.

In eastern Malaysia, Timor was known for its fragrant wood in earlier centuries. During the period 1510–1640 the Portuguese dominated the sandalwood trade with their establishments in Timor, Malacca, and Makassar. Sandalwood gathered from Timor was delivered to India and southwest Asia through Malacca, and to Macao and hence to China through Makassar. As the Dutch appeared, Batavia replaced Malacca as center of the trade. Subsequently the trade declined in the late 18th century because of depletion of supply in Malaysia and competition from the Hawaiian Islands.

The dense cover of sandal forests of Hawaii and Kauai formed the basis of sandalwood trade between the Hawaiian Islands and Canton, which was initiated about 1775 by some fur traders from America. From 1775 to 1830 heavy cuts of sandalwood sustained the profitable trade across the Pacific but exhausted the supply of the Hawaiian Islands. It was a trade between local chiefs who ordered their people to gather the wood and exchange it for foreign articles, and American merchants who carried the product to Canton in exchange for silk and tea to ship back to the United States. By 1829, sandalwood was depleted in the Hawaiian group, and control measures were effected in 1842.

NELSON C. CLARK—*Indonesian Kampongs as a Cartographic Problem*

The aeronautical cartographer must concern himself with the selection and portrayal of unusual population settlement patterns unique to various parts of the world. Only those which are found to have sufficient permanence can be justified for use on aeronautical cartographic products. This justification is the result of an intensive analysis of the settlement pattern itself.

Indonesian kampongs were recognized as a type of settlement pattern which differed greatly from adjacent populated areas. Through an analysis of the kampongs in relation to other populated areas, the problem of selection for inclusion was answered. Examination of geographic, historical, economic, and sociological factors resulted in the division of kampongs into rural, semi-urban, and urban types.

The division of the kampongs into three types facilitated the analysis for justification of inclusion. Each type was found to have different reasons for the same high degree of estimated permanence on the Indonesian landscape. However, the appearance of the three types was found to be similar enough to make use of the same portrayal method.

This cartographic problem serves to illus-

trate how the aeronautical cartographer must utilize a good academic background in a number of disciplines to guide him in his search for a solution.

SAUL B. COHEN—*Location Research Programming for Food Wholesalers*

Food retail outlets fall into three general categories: (1) corporate chains, (2) wholesaler-affiliated, either as voluntary groups or retail cooperatives, (3) unaffiliated independents. The second category accounts for 40 percent of U. S. retail food sale. To compete effectively with chain stores, affiliated retailers seek from the wholesaler purchasing, warehousing, and retail store services.

Examination of territories served by ten leading wholesalers with voluntary affiliates shows that widest area coverage and strongest market penetration occur in rural areas, small cities and towns, and sparsely settled portions of metropolitan areas. Less than 2 percent of the wholesalers offer store location analysis service to retailers, mainly without basic scientific procedures.

This paper discusses a store location research program that has been developed for three non-competing wholesalers. Their contiguous territories serve 4 million people within New England. Through jointly sponsored research, an adequate base of data and experience for broad development planning and store site analysis has been formulated.

Problems are encountered that do not occur in chain store organizations because of the absence of close controls that characterize chain store operations. These problems include: inter-wholesaler boundary frictions; competition among affiliated retailers; matching capabilities of store owners to trading area potentials; adjusting empiric data bases to weight wide variations in the store operational procedures of independent owners.

For geographers, this pilot project has a dual value: (1) it provides the university-based consultant an opportunity to guide a continuing, systematic appraisal of a varied marketing area, and to test challenging hypotheses in marketing geography; (2) it creates new employment avenues for talented graduates.

JOHN WESLEY COULTER—*The Problem of Overpopulation in Morocco*

Morocco has greater contrasts in its natural environment and more problems of human geography than any state in the Western world, and, indeed, than many countries in the Orient. One of the more pressing of these is overpopulation—a situation tied up with other problems of the economic progress of an underdeveloped country. Eighty percent of its ten million people live by farming, including pastoral activities, but they earn only one-third of the national income. Great contrasts in climate are a feature of the physical geography. It is during seasons of drought that the population suffers especially from lack of food.

Among native crops cereals hold by far the most important place, in regard to both acreage and value of products. Methods of agriculture are primitive. To help sustain its hungry people the Moroccan government in 1959 began a campaign to promote eating fish, the catching of which has been little developed. It is also trying to ease the situation by increasing foreign trade. Social problems retard the solution of economic difficulties in this newly independent country. A political situation adds to the King's worries, for there has never been an election.

The author of this paper takes exception to one of the ways the Moroccan government is trying to solve its problem, namely, by plowing up thousands of acres with tractors and harvesting the cereals by large-scale machinery.

Improvements in agriculture, education, and social and political affairs must all go hand in hand.

DALE E. COURTNEY—*Problems of Predicting Land Use in Underdeveloped Areas in the Humid Low Latitudes*

A system of predicting land use may be a tool of value to land planners in underdeveloped areas. When a system of predicting is applied to a crop or crops for a selected area, two types of problems are encountered: (1) those related to the acquisition of data of physical characteristics and productive capacity of the area, and (2) those related to dynamic factors of land use which, as they change, may alter the patterns of land use. Problems of the second type are considered in this paper as they

relate to predicting land use for sugar cane in an area in western Puerto Rico which exhibits characteristics that are typical of large parts of the humid low latitudes.

The problems considered here derive from factors which originate both within and outside of the study area. Representative of those of local origin are attitudes of the farmers, farming practices, mechanization, competition with other crops, and size of land holdings. Representative of those of external origin are markets and quotas, subsidies, and competition with other producing areas. As an example of the problems posed by these factors, those raised by mechanization are discussed in detail. The primary value to planning of a system of predicting land use lies in bringing into focus the factors that can cause change, rather than in predicted acreages and yields.

RAYMOND E. CRIST—*Rice Culture in the Camargue*

Rice culture was introduced by the Arabs into Spain, Italy, and the Balkans, probably in the 11th century. Small plantings were reported in Provence from the 14th to the 16th centuries. At the beginning of the 20th century there were some 800 hectares of rice in the Camargue, that sector that has been gradually reclaimed from the sea by the natural process of deposition of silt by the Rhone River. However, in view of low yields, poor quality of the grain, and high milling costs, the growing of rice in the Camargue had been practically discontinued by the end of World War I.

Activated in large part by the food shortages consequent upon the German occupation (1940–44), French rice culture in the Camargue has evolved as the result of the coaction of a series of favorable factors, in spite of extremely high labor costs as well as high prices for machinery.

The following is a list of significant factors that were or still are operative in making the Isle de la Camargue an important rice-producing area:

1. The loss by France of tropical rice-producing colonies, and the desire to produce its own foodstuffs.
2. The desire of outside investors to find a safe and profitable haven for funds, and the desire of landholders—large and small—to intensify land use and increase their income.
3. The tremendous increase in the production of American hybrid corn for use as animal feed.
4. The possibility of mechanization in many phases of rice production.
5. The availability of a cheap, docile, and experienced labor force for those tasks not so readily mechanized.
6. The depression in the wine industry and the interest of the government in an alternative crop.

HOWARD J. CRITCHFIELD—*Spartina Townsendii: A Significant Plant in Coastal Geography*

Spartina Townsendii, also known as Townsend's Cord-grass, is of botanical interest as an allopolyploidal hybrid of *S. stricta,* a European species, and *S. alterniflora,* of North American origin. Its geographic significance lies in its ability to establish itself aggressively on the tidal flats of coasts and estuaries, where it stabilizes mud and accelerates siltation. *S. Townsendii* was first recognized on Southampton Water, England, about 1870. In less than a century it has been spread by natural and cultural means along the coasts of England and northwestern Europe. Areas of the grass on several estuaries of coastal England have succeeded in stabilizing salt marshes, thus affording protection to sea walls. In Holland, *S. Townsendii* has considerably accelerated the early stages of land reclamation on the tidal muds of the province of Zeeland. The grass has been established on mid-latitude coasts in several other parts of the world. It tolerates a fairly wide range of climatic conditions. In New Zealand, *S. Townsendii* thrives at Invercargill at the extreme south of South Island, and another planting is spreading through a mangrove swamp at Thames on North Island.

Besides its use in tide-flat reclamation and control of tidal scour, *S. Townsendii* can be grazed by farm animals. In certain circumstances it may create a threat to navigation channels.

JAMES I. CULBERT—*New Developments in New Mexico Coal Mining*

Coal covers an area of 16,200 square miles in New Mexico, and reserves are conservatively estimated at some 60 billion tons. Only about

twenty percent of this is bituminous, most of it located in the Raton area. Coal production in the state reached a wartime peak in 1918, then declined until 1940. There was a slight increase until 1943, and since then there has been a constant decline. Decreasing production has been due to the competition of other fuels and is not related to the quality of the coal nor to the size of the deposits.

Major outlets for New Mexico coal were for railroad and smelting uses and for space heating. When the Phelps-Dodge Copper Company abandoned its Dawson property in the early 1950's, the outlook for coal mining was bleak. The only remaining major producer, the St. Louis and Rocky Mountain Coal Company, sold most of its output to the Colorado Fuel and Iron Company. When the latter company opened its own mines in Colorado, the last important market for New Mexico coal apparently had closed.

The Kaiser Steel Corporation, seeking coking coal for its Fontana plant, purchased the properties of the St. Louis and Rocky Mountain Company in 1959. The known reserves, 400 million tons, are the largest west of the Mississippi. Several million dollars have been spent in modernizing the property, which because of low output had not been completely mechanized. An output of 3,000 tons per day is planned, which will be almost equal to the total output of the state in recent years.

As is well known in economic geography, developments in one area may have beneficial or adverse effects on industries in regions some distance away. So it is that the coal mining industry of New Mexico, almost destroyed by competition from petroleum products, has been given new hope by the growth of the steel industry in California.

LUELLA N. DAMBAUGH—*The Everglades National Park: A Wilderness Reserved*

The Everglades National Park—newest, most southerly, and third largest national park in the United States—was the first park in which biological rather than geological features were emphasized. There is a complete absence of human settlement within the boundaries fixed July 2, 1958. All species of wildlife—resident and migratory birds, land animals, and marine life—are carefully protected.

Fresh water and salt water prairies, dotted with "hammocks" and "heads," cover about 75 percent of the surface; mangrove forests and piney woods take up much smaller areas.

Miami oolite underlies the eastern and higher portion of the park, while the western half is underlain with the Tamiami Formation. The comparatively level land drops in elevation only two or three inches per mile toward the southwest. Fresh waters from Lake Okeechobee (about 60 miles north) normally drain through the park to the Gulf and Florida Bay —a prime requisite for the food chain upon which wildlife depends.

Problems yet to be resolved have to do with: (1) the need for proper orientation of an ever-increasing number of visitors, (2) fire and drought during the winter season, (3) an accumulated excess of rainfall, such as occurred during 1959 when the water table rose to unprecedented heights and the area of dry land within the park was reduced, and (4) a clearer understanding and liaison between the basic needs of the wildnerness and the great supercity now developing in south Florida, especially in terms of the rationalization of the over-all plans of the Central and Southern Florida Flood Control Project.

RICHARD L. DAY—*An Analysis of Through Freight Traffic in the East St. Louis Gateway*

East St. Louis, Illinois, a transportation gateway situated at the southwestern corner of the American Industrial Belt on a direct line with the resource-rich and rapidly industrializing Southwest, is dominated by a heavy flow of through freight traffic. Taking the four means of surface transportation collectively, 78 percent of the freight traffic, or about 80,000,000 tons per year, is through in relation to East St. Louis, although only about 50 to 55 percent is through with respect to Metropolitan St. Louis as a whole. The 15 trunk line railroads move two-thirds of this through freight tonnage.

Petroleum products, primary metal products, chemicals, and unprocessed minerals are the four leading commodity groups moving in this through freight traffic, each group accounting for about 14 percent of the total tonnage. Paper and allied products, food products, and general freight are each responsible for approximately another five percent.

At least 85 percent of the through freight traffic at East St. Louis is calculated to flow along a general northeast-southwest axis, between the Industrial Belt and the Southwest, with about 60 percent of the tonnage moving toward the northeast and 40 percent toward the southwest. The southwestern end of this axis is anchored in Texas and the northeastern end in the heart of the Industrial Belt. California is a significant secondary anchor point to the west.

A series of maps depicts variations in the state-to-state flow patterns for several specific commodity groups important in through rail traffic.

GEORGE F. DEASY AND PHYLLIS R. GRIESS—*Localization of Electric Generating Plants; The Case of Pennsylvania*

Some 700 billion kilowatt-hours of electricity are generated in the United States each year. Most of this energy is produced by generating plants of moderate to large capacity. Various factors are known to be instrumental in determining the localization of such electric generating plants, especially fuel, markets, and availability of water. Labor and capital are of negligible significance as localizing factors, since both are highly mobile within the country.

In an attempt to determine the relative significance of fuel, markets, and water as localizing factors in the electric generating industry, a cartographic analysis is made of the situation in Pennsylvania. Results indicate that, at least in this state, fuel cost differences are of little importance. The market factor apparently determines the gross distributional pattern of moderate to large capacity generating plants, and the water availability factor delimits more precisely the sites that are suitable for such plants.

Primary determinant of the relative significance of the several localizing factors is transport costs. At the present stage of technological development, it is less expensive to ship the fuel necessary to generate a given quantity of electric energy a given distance, than it is to transmit the same quantity of electric energy the same distance. Moreover, it is less expensive to move both fuel and generated electricity than it is to transport the huge volumes of water required by modern power plants.

DAVID J. DE LAUBENFELS—*The Similarity Between Lighter Tropical Forest and Temperate Forest*

The well-developed seasonal forests of the tropics and the middle latitudes have strikingly similar appearances. Both have deciduous and xerophilous evergreen members. As a corollary both may have purely deciduous or purely evergreen phases. This is likely because any given forest stand consists of only a few dominant trees and the nature of the forest will depend upon the personality of the few dominants. Needle leaved trees are an extreme form of xerophilous adaptation and are commoner in colder areas just as broad-leaf evergreen trees are commoner in warmer areas, but their ranges overlap widely between the middle latitudes and the low latitudes. Disturbance can modify any forest and diminish the variety of plant species within it. Although lighter tropical forests and temperate forests are largely discontinuous from one another, they do come in contact in a few places. In these places plant formations at least sometimes cross the tropical-temperate boundary with no difficulty. Several kinds of variation are common to lighter tropical forests and temperate forests but no strong differences separate them. Together they produce a reasonably homogeneous category of forest and should in my opinion be recognized as forming a primary category of vegetation. Because lighter tropical forest and temperate forest occupy a mean position from which other forest formations are distinguished, it might be useful to call the combination ordinary forest.

WALTER WILLIAMS DESHLER—*Native Cattle Keeping in Eastern Africa*

One of the dominant aspects of the cultural landscape of the semiarid zones of both eastern and western Africa is the huge herds of cattle kept by the tribes of these areas. In eastern Africa the Masai, the Suk, the Karamajong, the Nuer and others maintain herds of from four to ten animals per person. Cattle are an all-pervasive aspect of the cultures of these often diverse tribes who are spoken of as people of the "cattle complex." Cattle are a medium of exchange, they are of ceremonial importance, and they have great esthetic value.

There are some puzzling aspects of this cat-

tle complex. One problem is that while the productivity of cattle is low, and the consumption of cattle products limited, the number of animals kept is so large as to induce long-run land damage. Yet government sponsored stock-reducing programs meet with widespread opposition. The basic question of why the large herds are felt to be necessary has not as yet been well answered.

This paper analyzes the subsistence aspects of cattle keeping among a Karamajong tribe of northern Uganda. On the basis of the evidence presented the suggestion is made that while the productivity of cattle is indeed low, other means of subsistence in these areas provide such low and erratic yields that cattle on the hoof are the only means of food storage and so are seen as a famine hedge essential to survival. The applicability of this thesis to other areas is considered.

C. WALLACE DIERICKX—*The Results of Testing the Geographical Background of Over* 1000 *Entering College Freshmen*

With the increasing enrollments predicted in U.S. colleges in the 1960's already engulfing some universities, many departments of geography are, or will be, faced with the problem of classifying huge groups of entering students into the proper courses of geography. Merely to place freshmen, many with little geographic background, into a single group would probably debase a beginning course to the high school or even elementary level.

This paper examines the results of testing over 1000 entering college students in order to find out their geographical background before assigning them to their first geography class. Examples are given of the questions asked, the possible answers, the right and wrong answers selected, and the type of work done on the two map tests, one on the U. S. and one on the world.

These tests show a remarkable range of differences among entering students in the Chicago area. As a result, Chicago Teachers College (which requires one semester of physical and cultural geography of all its students) inaugurated what was probably the first *required* non-credit course in college geography in the United States for entering students who, while qualified in general for admission to college, were not qualified to take a college-level credit course in geography. This program has been in effect now for four semesters, and the test results give an excellent current source of knowledge on what geography departments in the United States can expect to find among their incoming students in the next few years.

ARTHUR H. DOERR—*The Philippines—Purgatory or Paradise?*

As a nation with a long, distinguished, and varied cultural history, politically free only recently, the Republic of the Philippines shares many of the same problems and aspirations of her newly independent sisters. All these new nations share similar nationalistic feelings, and all of them are struggling to maintain political and economic integrity. All are nations with great expectations. Most of them have become convinced that their country could support many more inhabitants in far better fashion than at present. Scientists and social scientists who have examined the Philippine scene support Filipinos in their belief that the Philippines is a land of opportunity. Are Philippine economic and social prospects as bright as the optimists report?

At present, economic growth is not keeping pace with the steeply spiralling population curve. A history of profligate resource use has reduced productivity in many areas. Irrational national planning has failed to solve basic economic problems. The lack of an inventory of natural resources has hampered resettlement attempts, and inept pioneering efforts have been miserable failures.

A thoroughgoing land inventory, a stabilized or *slowly* growing population, a powerful professional planning group, a sound and intensive education program, a re-orientation of production and trade, increased governmental stability, expanded foreign aid, improved transportation and communication facilities, and greatly improved agricultural and conservation practices are essential to the future economic well-being of the Republic of the Philippines. It is largely a matter of the posture of the Philippine government whether the Philippines become purgatory or paradise.

EDWIN DORAN, JR.—*Landscape Changes on Tarawa Atoll*

Tarawa Atoll is remembered by Americans as the scene of a most sanguinary battle of World War II. In addition to this distinction, however, the atoll is the capital of the Gilbert and Ellice Islands Colony of the United Kingdom. Its population has doubled in the last decade, and a major program of reconstruction has taken place within the same period. A description of the present cultural landscape, which as a result of an administrative decision in 1946 has risen Phoenix-like from the nearly complete devastation of the war, is of interest. Just as interesting, perhaps, is an examination of the reasons why Tarawa has been selected repeatedly in the last 70 years to serve as the headquarters of the Gilbert Islands.

Brief sketches of earlier landscapes are given as perspective to the present. Nineteenth-century reconstructions, with whalers, beachcombers, and missionaries as the only white men present, and data from the 1930's, when only two dozen Europeans lived on Tarawa, are presented. The wartime scene, during the occupation by thousands of Japanese and then Americans, is sketched.

The Tarawa of August, 1959, is described with the aid of color photographs and maps. Included are data on the 250 Europeans, sizable administrative staff, new colony and district headquarters buildings, 250 newly constructed houses, new schools, hospital, and many new commercial buildings as well as the new harbor.

The repeated choice of Tarawa as the principal site of activity in the Gilbert Islands, by British, Japanese, Americans, and British again, is related to the complex of physical, cultural, and historical factors which seem to explain its selection.

JOHN E. DORNBACH—*Translating the Chart Through Design*

A review of past literature by geographers, educators, and cartographers indicates general agreement that the map may be considered a "foreign language" which must be learned before it can be understood and used. Recently, investigators have begun to question the validity of this assumption. Innovations in aeronautical charting indicate that it is possible to "translate" the chart into meaningful cartographic terminology for the user.

The ACIC is now producing charts, such as the Operational Navigation Chart, on which special effort is made to translate the cartographic information into terms immediately usable by the pilot or navigator. It is the opinion of aeronautical chart cartographers that principles substantiating current design practices of the U. S. Air Force for terrain representation, symbols, etc., can be directly applied to the design of many of the geographer's maps.

In psychological terms, it has been determined that the visual task of the map user must be unburdened—the cartographic information so designed as to be immediately capable of translation into visual imagery of meaning to the viewer. The viewer is not forced mentally to integrate, differentiate, and correlate various bits of unrelated data into a meaningful whole. A parallel will be drawn between film-strip graphics and computer tapes produced for the USAF F–106 Fighter Interceptor and the methods by which general geographic maps may be improved.

MARGARET B. DOWNS—*The Determination of Regional and Extra-Regional Markets in a Historical-Economic Geographic Study*

How can *past* industrial growth, particularly changes in market areas, best be estimated in an economic geographic study of a region? This growth is most often shown by the ranking of leading industries according to the number of people employed in each. These figures are readily obtained from census data. This method has its merits but gives no clue to the *extent* of the market served by the industry under consideration. Since industrial development depends upon an expanding market, a dominance of the extra-regional industry over those supplying regional or local needs is indicative of growth.

In a study of the "Industrial Structure and Pattern of the Wheeling District, Its Evolution and Development, 1840–1950" (Ph.D. dissertation, University of Maryland, 1957), a method of determining probable market area by type of industry was developed under the direction of Victor Roterus, Chief of the Office of Area Development of the U. S. Department of Commerce. This method is based on deter-

mining the national consumption index for a particular industry, and then applying this index to local statistics in order to estimate the extent of local consumption of that industry's production. The general area of service or market area of various types of industry can be determined roughly by a comparison of national and regional employment figures.

Tables constructed for the years 1840 and 1880 in the Wheeling District showed that the method, while crude in light of some of the possible ramifications of the formulae, was quite feasible and effective in measuring markets and growth when other statistical records are not available.

ROBERT R. DRUMMOND—*Sino-Burmese Boundary Disputes*

When the British annexed the Kingdom of Upper Burma in 1886, they inherited the problems of the ill-defined boundary between Burma and the Yunnan Province of China. The British strove to establish a watershed boundary between the Irrawaddy and the Salween rivers. This effort was complicated by the similarity of peoples on both sides of the watershed, and by the reluctance of the Chinese government in Peiping to ratify any agreement which took place on the frontier. The British watershed boundary was finally ratified in 1941. However, various Chinese maps published during World War II and afterward have laid claim to nearly 80,000 square miles of Burmese territory, mostly north of Myitkyina. The government of the Peoples' Republic of China has seen fit to keep alive this dispute since their assumption of power. The Burmese government has generally been prone to look with favor upon most of the Chinese claims, although the military government which came into power in October 1958 has shown signs of taking a firmer stand on the boundary question.

The immediate claims of the Chinese Communists are three: (1) certain areas of the Wa States which were partly unadministered even under the British; (2) the Namwan Tract, a one-hundred square mile area at the junction of the Namwan and Shweli rivers; and (3) the Hpimaw area, comprising about 65 square miles north of latitude 25° 35′, astride the Irrawaddy-Salween watershed.

In any negotiations concerned with cession of these areas, there arises the problem of the disposition of nearly 10,000 persons who live in these disputed tracts, and the important Burmese Namkham-Bhamo highway (a portion of the Ledo Road) which passes through the Namwan Tract.

GARY S. DUNBAR—*Colonial Carolina Cowpens*

Historians, especially following Turner, have magnified the extent and importance of eighteenth-century open-range livestock operations in the Carolinas. The statement has been made that "the livestock industry of the Carolina Piedmont in the 1760's was remarkably similar to that of the Great Plains in the 1880's." The present paper is not a comparative study of the industries of the two times and places, but rather it is a particular treatment of cattle-raising as it developed in the Carolinas, not only in the Piedmont but also in the coastal plain, where the industry was generally more important. Emphasis is placed on the size of herds; methods of handling or organization; the nature of the preferred grazing areas, such as savannas, cane swamps, and "peavine pastures," and the variety of uses of the term "cowpen," which apparently meant anything from a small enclosure to a large grazing area, ranch, or frontier community. Possible later links between the Anglo-American cattle tradition of the Southeast and the great Spanish-Mexican tradition are examined.

JOHN R. DUNKLE—*Site and Function in St. Augustine, Florida*

The site of St. Augustine has been continuously occupied by white man for almost two centuries. Physical attributes of the site have changed but little. Cultural phenomena have varied greatly with Spanish, English, and American occupance. Here, then, is a "geographic laboratory" in which a set of variables operate on a set of constants with enough time lapse so that results may be evaluated. This paper observes the constants and variables and attempts to assess the results. Special emphasis is given to an appraisal of the degree to which the site was suited to the various goals or functions of the community.

As the years passed, St. Augustine was in turn a garrison center, a port of entry for agricultural colonization, a political capital, a cit-

rus center, and a tourist community. While the site did not change the particular attributes which were critical varied, as did the function of the city. For example, the shallow harbor favored protection of the garrison but impeded, at a later date, commercial development.

Documentation is thorough and includes old maps as well as Spanish and English records. A detailed treatment is therefore possible. This paper examines the varying functions of one city as they impinge upon site and location in the belief that such appraisals of the past may aid in appraising current phenomena.

ARTHUR D. EARICK—*The Industrial Potential of Stillwater, Oklahoma*

Stillwater, Oklahoma, an education-centered community, desires to expand its economic base by industrialization. To meet the competition of other industry-seeking communities, Stillwater needs to concentrate on attracting those industries that its resources can support best.

Raw materials other than agricultural products are not readily available to Stillwater and bulk-shipping facilities are limited. The completion of new interstate highways will give Stillwater good truck connections to major urban areas of the Great Plains and the Central South.

Large supplies of low-cost gas are available for power. City-owned electric and water supplies are relatively high cost and the water supply is uncertain.

The labor force is composed largely of semi-skilled workers. It is reliable and pay scales are relatively low. Wives of university students form a pool for clerical and secretarial help. Engineers and scientists of the Oklahoma State University staff are available for consultation and many graduates desire to remain in a university community.

A potential market for aircraft parts is noted in the location of aircraft plants at Wichita, Tulsa, Dallas, and Ft. Worth and Tinker Field air supply depot near Oklahoma City.

Street repair and cleaning, better garbage collection, and flood control are community problems. City planning just getting under way should improve the industrial climate.

This study indicates that Stillwater should emphasize its labor supply, the research and consultant facilities of Oklahoma State University, and its location in relation to industries distributed within its primary market area.

W. GORDON EAST—*The Concept and Political Status of the Shatter Zone*

In recent decades geographers have been at pains variously to delimit and name a large easterly part of Europe and thus to distinguish it from the major regions which lie to the east and west. The announced criteria of this regional definition are many and varied: location, accessibility, physique, climate, and cultural factors of several kinds. Above all, significance is claimed for this region in respect of its human geography, past and present, and more especially of its political geography in peace and war. It stands apart from the rest of Europe by reason of the complex distribution of its nationalities and languages, its relative backwardness, and its politico-territorial instability. The concept of *stage* clearly applies to its social, economic, and political status. Certainly it has been continually exposed to external pressures—from the west and from the east—yet at times countries within it were themselves vigorously expansionist.

This paper examines the names given to this area of East-Central Europe and the validity of the claims made for its characterization. While the term "Shatter Zone" has come into fairly common use among geographers during the last 20 years, recognition of the importance of this region in political geography dates back to an article published by Dr. J. F. Unstead in 1923. Clearly interest was focused on the Shatter Zone by the territorial changes brought by World War I.

In conclusion, the present and prospective political situation of the Shatter Zone is considered in the light of the past.

BART J. EPSTEIN—*Evaluation of an Established Planned Shopping Center*

Experience has demonstrated that serious thought must be given to location with regard to planned shopping centers. Decisions on location must be based on retailing experience, market data, and store and center characteristics. This study of Hamden Plaza, Hamden, Connecticut, presents a methodology for evaluating a planned shopping center.

Data on its whole trading area, the trading

area of its major units, and such characteristics as means of customer transportation, sex of customers, frequency of patronage in downtown New Haven and at the shopping center, and the extent of cross-shopping among the center's stores were obtained by interviewing a daily sampling of customers in the center's parking lot for the period of a full business week. Specially designed interview forms were devised; and a novel cartographic technique was developed for trading area analysis. A market analysis of the New Haven metropolitan area provides the analytical framework of the study.

Hamden Plaza is considered well located and functionally well arranged, but success among its tenants has not been uniform. The supermarket, variety store, and one junior department store experienced good acceptance and success. The other junior department store has not fared so well. Hamden Plaza as a whole has been successful, inviting new competition nearby.

VIRGINIA P. FINLEY—*Operation "Cold Deck": New Horizons in Photointerpretation*

Operation "Cold Deck" was a joint U. S. Air Force–Corps of Engineers project designed for research in airborne sensing methods of terrain analysis and related photointerpretation problems. During the period from September 1958 to March 1959 seasonal visual photography and thermal imagery were obtained over ten selected targets in the Houghton, Michigan, area. Selection of targets was based primarily on topography-soil-vegetation factors and variety of existing cultural features. Visual photography, at several scales, was taken simultaneously on panchromatic, infrared, color, and color reversal film. Daylight and night (with and without moonlight) thermal imagery was recorded using different types of detectors. Insofar as possible field teams collected ground data at the target sites during each flight.

Preliminary analysis of photography, imagery, and ground data indicates both positive and negative results. The possibility of selecting preferred film-filter-scale combinations for specific interpretation problems is encouraging, particularly in the analysis of snow and ice surface features, vegetation studies, and interpretation of cultural features. The soil moisture and subsurface target studies disclosed the need for extensive additional research.

Thermal imagery was found to be valuable in supplementing visual photography for general interpretation purposes. Its special-purpose potential is just beginning to be recognized. The obvious need for further research resulted in the continuation of a modified Operation Cold Deck II during the 1959–60 season. This phase of the study is concerned primarily with thermal imagery and is being conducted in cooperation with Project Michigan.

BARRY NEIL FLOYD—*Changing Patterns of African Land Use in Southern Rhodesia*

This paper records and analyzes certain new and significant patterns of land use and settlement within the native reserves of southern Rhodesia. These patterns are resulting from an ambitious program of tenurial reform and improved farming practices in the African areas, sponsored by the Rhodesian government.

Increased pressures of a growing population upon limited and deteriorating land resources have made the need for widespread changes obvious. A Native Land Husbandry Act was passed in 1951. This important piece of legislation has been publicized as the most radical and far-reaching attempt to improve native farming ever proposed in tropical Africa.

A Five Year Plan for implementing the N. L. H. A. was launched in 1956. It entails complete abandonment of the traditional tribal systems of land holding and the primitive methods of subsistence, shifting agriculture. In their place is being substituted a commercial system of improved, settled farming, based upon pride of title to the land and a money economy. Individual farming and grazing rights are being granted to eligible farmers under government, not tribal, allocation. Reasonable minimum standards of good husbandry are being established, covering soil conservation (contour terracing, crop rotation, manuring, and so forth), livestock improvement and farming practices generally.

The geographic analysis of these agricultural and sociological changes is based upon field work in a number of native reserves where the author was recently employed as a Land De-

velopment Officer by the Rhodesian government. The paper is supported by maps and colored slides.

FRANCIS L. FUGATE—*South Texas: Birthplace of the Range Cattle Industry*

The cattle industry of the West was born in the southern tip of Texas, an area roughly bounded by the Nueces and the Rio Grande rivers. The industry was the child of a polygamous and often contentious marriage between war-weary, bankrupt soldier-settlers and an unlikely assortment of helpmates: arid, inhospitable land; a population explosion among abandoned Spanish cattle; hostile Indians and quarrelsome neighbors; speculators and impresarios, both native and foreign; a vogue for buffalo robes; droughts and severe winters; financial disasters; encroaching farmers; and a meat-hungry nation.

Texas cattlemen bankrupted their lands and themselves by producing an oversupply of cattle for northern pastures, thereby creating their own competition in the form of more palatable beef. The Texas cattle industry then bettered its lot by introducing scientific methods into the improvement of both land and cattle, and is now setting forth on another cycle by supplying improved breeding stock and ranching techniques to foreign lands which have hitherto been comparatively unsuccessful as beef-producing areas. By coupling this trend with current research into methods of meat preservation, one can foresee vast surpluses of meat mounting up beside vast stores of wheat and other foodstuffs.

ROBERT H. FUSON—*Caicos: Site of Columbus' Landfall*

Christopher Columbus first visited and named four islands in the Bahamas: *San Salvador, Santa María de la Concepción, Fernandina,* and *Isabela.* The exact locations of these were never charted, though various cartographers between the 16th and 19th centuries surmised their positions and "mapped" them. During the 19th century there was a renewed interest in the First Voyage. Since no maps correctly identified the first four islands discovered by the Spaniards, there occurred a reckless scramble by historians to pinpoint *the* landfall. Regrettably, each investigator first selected an island he thought was *San Salvador,* and then attempted to prove that the choice was correct. With more than 700 islands and 2000 cays in the Bahamas, there was an island for every researcher. From this confusion of random selection, Walting Island emerged as the majority, but erroneous, conclusion.

San Salvador can be located by applying geographical techniques to the problem. It must be assumed that Columbus was an expert sailor who kept a reasonably accurate log. Fortunately, this log has been preserved, and from it that original voyage may be reconstructed. Other supporting information is varied and extant.

A chart based solely on the directions, distances, and descriptions of Columbus may be superimposed on a modern map of the Bahamas with remarkable coincidence. On Friday, October 2, 1492, Columbus landed on Caicos (*San Salvador* or *Guanahaní*) and visited, in order, Mayaguana (*Santa María*), Crooked-Acklin (*Fernandina*), and Great Inagua (*Isabela*).

WILLIAM L. GARRISON—*Accessibility of Urban Centers to Transportation Networks*

Much current information on the development of urban centers and the relationship of this development to transportation is organized around what might be termed site concepts. For example, certain places are characterized by location at the head of navigation, others are characterized by location at break of bulk points, and so on. Except for the notion on intervening opportunity, little information is organized around concepts of the transportation system as a whole, and the accessibility of particular places to the transportation network.

Recent developments of the theory of graphs suggest some ways that transportation networks may be analyzed. An exploratory study of the Interstate Highway System has revealed the usefulness of concepts of the accessibility of places to the transportation network and the accessibility of the transportation network to places. Also, this type of analysis is extremely suggestive for problems of the development of transportation networks and urban centers in underdeveloped areas. As links are added to the transportation network the relative acces-

sibility of places to the network may change markedly. Observations in India and South Korea illustrate these changes.

ARTHUR GETIS—*The Service Function of Cities*

The results of a theoretical study of service functions reveal the great importance of such functions in explaining the character and location of central places. In an analysis of the characteristics of some of these services, it was found that a set of operational principles could be developed which explain the relative importance of cities in the economic landscape. Total sales per worker in selected service activities were computed for a large number of cities. Variations in these data were extremely small within each of the nine census regions of the United States; they were somewhat larger between regions. Differences in technology and living costs between regions account for this variation. For example, in the East South Central states grocery stores of the non-supermarket variety are common, while in the Pacific states supermarkets predominate, and living costs in the South are lower than in the West. By weighting these influences "retail worker support thresholds" were determined. Service activities and service workers are within areas where the buying power of the populace is *just* sufficiently large to support each worker.

RAY Y. GILDEA, JR.—*The Small Watershed Protection Program—A Summons for Geographers*

Today there is an urgent need for geographers to assist in the planning and evaluation of watershed management projects under Public Law 566.

The Watershed Protection and Flood Prevention Act of 1954 now assists local individuals in small watersheds to achieve measures aimed at flood prevention and agricultural development. A type example, the Lake Placid Watershed in Florida, amply illustrates the importance of geographic and economic data in the satisfactory development of a watershed.

To date over 120 watersheds are in the work-plan stage. They are concentrated primarily in the Northeast, Ohio Valley, Piedmont, and Midwest. However, the work loads placed on the supervising agency, the Soil Conservation Service, have been excessive. The Soil Conservation Service welcomes help and, in actuality, is directed by law to seek technical assistance.

What can geographers do? They can (1) furnish leadership as planning integrators, (2) assist as educators in making the public aware of existing problems and possible solutions, (3) participate as assemblers and analysts of basic data, (4) aid as evaluators of current and proposed watershed legislation, (5) serve as appraisers of our over-all watershed program; this contribution could be part of departmental research or graduate studies.

Here is a project that will definitely modernize the reputation of geography, will simultaneously provide genuine public service that is urgently needed, and, finally, will keep geographers abreast of the changing technology of resource-use.

WILLIAM GOODWIN—*Mapping Industrial Change: New Jersey as an Example*

This paper reports an experiment in mapping manufacturing trends in New Jersey. Two problems had to be solved: (1) to show on maps the dynamic aspects of manufacturing growth or decline, and (2) to identify changes taking place in the suburban industrial fringe.

County employment figures of each industry and of all industry for the period 1947–57 were plotted on semi-logarithmic graph paper; the secular trend was determined by the least squares method. The use of a historical series permitted a more reliable estimate of the trend than would the chance variation for two specific years. The equation of the trend was determined, and the average annual rate of change was calculated.

Each rate of change was then associated with a definite pattern. The patterns are a system of parallel lines set at different angles with respect to the horizontal and varying in width, permitting the rate of change to the nearest 1 percent to be read directly from the map. Other systems of patterns were prepared for comparison.

To identify the amount of change in manufacturing activity and the kind of industries involved in the surburban fringe required the identification of minor civil divisions having industry before the above procedures could be carried out.

If it can be assumed that there is reliability in the trends, these maps permit an estimation of the areas where growth and/or decline of particular industries can reasonably be expected.

MARVIN F. GORDON AND DONALD E. STARSINIC —*The 1960 Urbanized Area Program*

The Census Bureau's program for the delineation of urbanized areas for the 1960 census differs in major respects from that employed in 1950. Rather than attempt a precise field delineation of unincorporated areas of urban density adjacent to the central city as in 1950, the Bureau has demarcated a fringe zone of potential urban density around each city expected to have 50,000 or more people in 1960. The inner limit of this zone is the outer extent of proved urban density (generally the 1950 urbanized area), and the outer limit is that point beyond which urban density is highly unlikely. The unincorporated portion of the zone has been split for census-taking purposes into enumeration districts (ED's) much smaller in population and in area than those employed outside of the zone. Area measurements will be prepared for the fringe ED's, and when the census count becomes available those fringe ED's meeting density requirements of 1,000 persons per square mile and contiguous to the central urban mass will be adjudged a part of the urbanized area. The result is a more generalized delimitation of the urbanized area than in 1950.

In the last year the Bureau conducted a field survey of several test cities, experimenting with both the 1950 and presently adopted methods of delineating the urbanized area. An analysis of the findings of this survey with regard to differences in population and area covered in using the 1950 and 1960 methods will be incorporated into this report.

L. A. PETER GOSLING—*Moslem Law, Custom and Usage as Reflected in the Agricultural Economy of Malaya*

The Malay peninsula was converted to Islam in the 14th and 15th centuries. The introduction of a Near Eastern religion into an East Asian economic pattern affected the rural economy in many ways. Some aspects of Islamic law and usage have modified traditional East Asian agricultural patterns; others pose serious obstacles to rapid remedial agricultural changes that now would raise the living standards.

Excessive fragmentation of landholdings results from Moslem law which prescribes the shares for each heir and makes it impossible to disinherit any heirs. The Moslem lunar calendar creates difficulties in fixing planting dates, and adherence to the religious calendar of Islam, particularly the fasting months of Ramadan, often severely curtails agricultural operations. Prohibition of pork has eliminated the ever-useful pig from the rural economy. Other aspects of Islam have indirect effects. The pilgrimage to Mecca, required of all good Moslems, results in the dissipation of capital and even heavy indebtedness. Easy divorce leads to weakening of the family and the hoarding of available capital by the women for their own security. The rural economy is also influenced by customs which are firmly but erroneously believed to be part of Islamic law and usage. Examples of these are the distrust of cooperative societies because of their supposed usurious nature and the view that the use of manure in most forms is "unclean."

Religions usually bear evidences of the particular human and physical environments in which they develop. When transferred to a different environment a flexible religion may undergo considerable modification. However, the rigid doctrine of Islam did not make many such changes when transferred to humid Southeast Asia. Instead of adjusting the religion to the environment the adherents of Islam in Malaya have been compelled to adjust their traditional land use practices to the religion, resulting in certain maladjustments and problems.

PETER R. GOULD AND ROBERT T. SMITH—*Measuring the Relationships between Rail Shipments, Road Access, and Road Competition in Ghana and Australia*

Freight shipments to towns on a railway may be strongly influenced by the degree of road accessibility and road competition, but the relationships are often difficult to point up because they are masked by other variables, such as the size of the receiving centers and distance from the towns of origin. These relationships may be considerably clarified by correlating the rail shipments with the respective popula-

tions of the receiving centers and plotting the deviations cartographically.

Two examples have been chosen to illustrate the method. In Ghana, where the size of population explains 50 per cent of the variation in rail shipments, the pattern of positive deviations of rail shipments from Takoradi points up sharply the areas in which complementary road access for distributary purposes is an important factor. Similarly, the areas of strong road competition, as well as those in Accra's traffic shadow, are highlighted by the pattern of high negative deviations. In New South Wales, Australia, the pattern of negative deviations of rail shipments from Sydney points up not only those areas in the southern part of the state susceptible to rail competition from Melbourne, but also those areas where road competition is strong owing to certain transport regulations influencing interstate shipments.

HOWARD L. GREEN—*Planning a National Retail Growth Program*

Recently a national retail general merchandise chain decided to resume its expansion after a hiatus of fifteen years, as well as re-evaluate the status of its existing stores. Part of the planning process was to decide what geographic facts are needed to initiate a systematic action program.

Four major areas of geographic analysis are employed as part of this chain's program: (1) Define the existing and potential future market for general merchandise in terms of the distribution of people, their purchasing power and their shopping and expenditure patterns. (2) Relate the distribution of the chain's existing stores to the long-term market potential. (3) Evaluate the extent to which individual markets are served by existing general merchandise stores of all types. (4) Propose a strategy for maintaining existing stores and building new ones in specific markets.

ANDREAS GROTEWOLD—*International Trade and Economic Geography*

Many geographic studies of ports, transportation routes, agricultural, mining, or manufacturing districts have given consideration to the trade which is basic to the operations carried on at a particular place or along a particular route. Customarily such studies are regarded as contributions to the fields of urban, transportation, agricultural, or industrial geography. The geography of international trade, as the present writer sees it, centers on the exchange of goods and services among nations; it takes for granted the production, transportation, and marketing facilities as they existed at any given place at any given time.

By this definition the geography of international trade is virtually a virgin field of inquiry. So far, geographers have paid attention to it only occasionally, and the few studies they have produced are limited in scope. Such disregard for the study of international trade suggests that its significance to the field of economic geography is not generally appreciated. This paper attempts to show by specific examples how a knowledge of international trade is basic to an understanding of three important aspects of economic geography, namely (1) the economic allocation of the world's resources and the international division of labor, (2) the functioning of national economies, and (3) the world's economic organization.

LEE GUERNSEY—*Land Use and Settlement Changes Caused by Strip Coal Mining in Indiana*

Strip coal mining has created about 93,800 acres of spoil banks within 15 counties of southwestern Indiana. Of this total about 50,500 acres were formerly in cropland. Since 1941, when Indiana passed the first law in the United States which required the coal companies to reclaim all strip-mined lands, all of Indiana's spoil banks have been legally reclaimed.

This paper shows the location of Indiana's strip-mined lands. It also analyzes salient impacts of strip coal mining upon the agricultural land uses and rural settlements of all townships wherein strip coal mining has occurred. Measurements were made of the extent and location of idle spoil banks and the type of vegetation which prevailed on all reclaimed lands. Estimates were made of the type, amount, and location of recreational areas within the strip-mined lands.

Strip coal mining encroached upon 1,305 farms; 405 farm families moved after selling their land to coal companies. Trees were

planted on 55 percent of Indiana's spoil piles. Grasses and legumes were sowed in about one-half the counties affected by strip mining, but comprised only 5 percent of the strip-mined area. Twenty percent of Indiana's spoil banks were used for recreation. The land use of Indiana's spoil banks was affected mainly by their texture and acidity, the proximity to urban settlements and highways, and varying attitudes of strip mine companies toward reclamation.

DONN K. HAGLUND—*The Alaskan Highway—Attendant Economic Development*

Although constructed and opened as a military road in 1942, the unpaved Alaskan Highway was not used by civilians including tourists until after the war. Now well into the second decade of such utilization, the degree of land use along the roadway remains negligible. At only three locations in the 1,260-mile stretch between the geographic margin of cultivation near Fort St. John, B.C., and Tok Junction, Alaska, is there an inhabited place with a population of over two hundred. These places are evenly distributed, occurring at approximately 300-mile intervals. Man-made structures of any kind, excepting bridges and the like, are encountered at a mere 161 locations (an average of one every eight miles) in this same traverse, and a large percentage of them are abandoned or unused. At 69 of the sites (i.e., one for approximately every 18 miles of roadway) are found traveler accommodations and services, varying widely in quality and completeness.

Mineral exploitation and exploration localities almost without exception lie well off the highway proper, although the highway does provide primary access to these undertakings. Lumbering is restricted to the first 100 miles of the route, and to the immediate vicinity of the few villages.

Most certainly the Alaska Highway will increase in importance as an avenue of transportation, being the only overland connection between the new state of Alaska and the contiguous 48, as the resources of the areas through which it passes are utilized to a greater extent. The magnitude of its importance will be determined largely by continental raw-material requirements, competitive extractive costs, and the building of connecting links to such places as Juneau. Furthermore, solution of maintenance problems, including eventual paving of the entire distance and improvement of service facilities (which undoubtedly would bring about a sizable increase in tourist use), also will affect the future development of this route.

ROBERT A. HARPER—*River Junction Communities of the lower Ohio Valley—A Functional Comparison*

The lower Ohio Valley provides a ready laboratory for study of a classic topic of settlement geography—the location of communities at river junctions. Within 160 miles four junctions of major navigable streams occur: the Ohio is joined, successively, by the Wabash, Cumberland, and Tennessee rivers before it itself joins the Mississippi. At each junction a settlement has developed, but the size and function of each varies markedly. Paducah, at the mouth of the Tennessee, is a city of 47,000; Cairo, at the Ohio-Mississippi junction, had 12,000 people in 1950, but has been declining and probably has less than 10,000 now; Mt. Vernon, Indiana, at the Wabash junction, has a population of 7,000; and, Smithland, Kentucky, at the Cumberland-Ohio union, is a hamlet of 500 persons.

In early days of settlement each community performed basically the same functions—as stop-over points for river traffic and as ports for local agricultural areas. With the coming of railroads Paducah and Cairo developed as major break-in-bulk points. Timber, assembled by rivers, came to these points for rail shipment; rail-delivered goods were distributed by river boat. The decline in river shipping and the establishment of bridge crossings eliminated these functions. Today, Paducah and Cairo have limited river connection. But Mt. Vernon has become a major break-in-bulk port, handling 4,396,404 tons in 1956. There coal bound for Chicago moves from water to rail, and oil from Illinois-Indiana-Kentucky fields moves from pipeline to barge.

PAUL C. HENLEIN—*Early Cattle Ranges of the Ohio Valley*

This paper will attempt to describe, briefly, the open grassland ranges of the Ohio Valley, mention some of their relations with other

regions, point out the beginnings of their evolution into Corn-Belt, and indicate one or two problems for future research.

The first range to support cattle was the west-central Ohio upland, where herdsmen tended cattle on the open range in herds of one hundred to three hundred until the end of the 1820's. In the 1830's and 40's large grazing farms were set up, but even then fencing came slowly.

A second range, the Grand Prairie of Indiana, lay northwest of Lafayette; and a third, the great prairie of Illinois, including Champaign and McLean counties, extended west into the Sangamon Valley and southwest to a point near Covington.

These ranges supplied stock cattle to the corn-feeding regions. The west-central Ohio upland, moreover, continued to provide summer pasture for Scioto Valley cattle as late as 1850. The settlers' probe of resource potentialities led to this sorting out or classifying of lands.

The coming of railroads and the partial conquest of the drainage problem prepared the way for the transformation of these ranges into Corn Belt; the relative weight to be given to the two factors might be debated. Once the Corn Belt began to emerge, its settlers drew upon the knowledge and breeding stock of the older feeding regions.

JOHN HILTNER—*Analysis of Possible Relationship between Commodity Price and Sown Crop Area in an "Underdeveloped" Country*

The generalization has been made that in countries operating under a capitalistic economic system, an association exists between agricultural commodity prices and crop acreages. This generalization can be refined to state that, all other things being equal, as the return per acre for a given crop in an area varies, absolutely or relatively, the area sown in that crop the following year also varies.

Similar generalizations concerning the behavior of agricultural prices and crop areas in the "underdeveloped" countries of Asia, South America, and Africa have rarely been made.

It is the purpose of this paper to investigate the relationships between price received in the market place and crop acreages in an "underdeveloped" country to determine whether evidence exists to support a generalization comparable to that stated above. The area selected is the Chukurova district of Turkey.

The investigation consists of a comparison of commodity prices received for selected crops in the Chukurova's principal market place and the crop acreages within the area over an eight-year period. The distance from production area to market place is also considered as a variable affecting crop plantings for years for which information is available.

The results of the study indicate that some basis for a price-area generalization exists. However, shortcomings in available statistics and the short period for which statistics are available render the generalization tentative and limit its application. They also indicate that further study with more complete statistics might prove profitable.

JORDAN A. HODGKINS—*Regional Patterns of Soviet Production and Consumption*

While the Soviets have achieved some success in shifting coal production eastward, both production and consumption have remained centered in European Russia.

Production of coal in the Soviet Union increased by 1,242.0 percent between 1913 and 1955. Ancillary to this growth has been a decreasing dependence on European Russia, especially the Donets Basin, as the primary supplier. European Russia, including the Urals and Caucasus, mined 92.2 percent of all coal in 1913 with the Donets accounting for 86.8 percent of total Russian production. By 1955 this region produced just 65.3 percent of the coal, and the Donets' share of total Soviet production was 36.0 percent. Production in all of the eastern regions constituted but 7.8 percent in 1913, but in 1955 these regions mined 34.3 percent of the Soviet coal. Major eastern coal producers in 1955 were: the Kuznets, 15.0 percent; Karaganda and Ekibatuz, 7.1 percent; Middle Asia, 1.7 percent; East Siberia and Transbaikalia, 6.2 percent; and the Far East, 4.3 percent.

Consumption has remained relatively stable despite the eastward shift in production. European Russia consumed 78.2 percent of all coal produced in 1940, 78.1 percent in 1950, and 77.3 percent in 1955. Outstanding consuming regions in 1955 were: the Ukraine, 24.3 percent; the Central Region, 20.5 percent; and the Urals, 20.5 percent.

Imports from the east into European Russia have increased in proportion to the shift in coal production from European Russia to eastern regions.

GEORGE W. HOFFMAN—*The Geography of United States Foreign Aid: Yugoslavia, A Case Study*

Geographers must take account of new forces in the ever-changing economic and political structure of individual countries. Foreign aid in its various forms is one force, the major objective of which is the preservation and strengthening of independence. This is accomplished by assisting certain countries in their economic development, especially in raising their standard of living. Generally speaking, foreign aid is extended as outright grants, credits repayable in various foreign currencies, and defense support. Normal commercial transactions are excluded. Vital goods and technical assistance are supplied to countries which have insufficient means, especially those lacking foreign exchange.

This paper points out the various forms of aid Yugoslavia has received since 1943. Massive foreign aid became necessary as a result of the break with the Soviet Union when Yugoslavia had to bolster its military forces against threats by the Soviet bloc and at the same time re-orient its foreign trade. United States aid was aimed at assisting Yugoslavia to develop her resources, especially by modernizing and increasing her extensive mining and agricultural activities. A large part of foreign aid consisted of shipments of essential foodstuffs and raw materials. A small but vital form of aid was technical assistance. Part of the United States aid was repayable in dinars, to be used for essential projects by joint agreement only, e.g., flood control, agricultural developments, port developments, highways, health services, etc.

Foreign aid is making important contributions to a rapid change in the economic structure of Yugoslavia, thereby altering old established social customs and lessening the large regional diversities.

DAVID JOHN MAHLER HOOSON—*Growth and Distribution of Soviet Cities*

The dynamics of the geographical pattern of cities in the Soviet Union has become curiously similar to that of the United States. Each country now has about 300 cities with over 50,000 inhabitants and each boasts about 75 which have doubled over the last two decades. About two-thirds of the latter are east of the Volga and west of the Mississippi, respectively —the first comparable period in which these "new" lands have claimed a majority of the boom cities of either nation.

Of some 20 regional groups of cities recognized in this paper, the Middle Volga and every region east of it (but none west of it) have recorded since 1939 a growth rate (in cities of over 50,000) at least as rapid as that of California or Texas.

Of the net increase of 24 millions in the Soviet city population (over 50,000) since 1939, 40 percent has accrued to the relatively narrow zone between the Middle Volga and Lake Baykal. This zone acquired as many new city dwellers in this period as did the industrial block of states between Massachusetts and Illinois *plus* Texas and California, but while these states contain two-thirds of the total U. S. population, Volga-Baykal still claims less than a quarter of the Soviet population. Its continued rapid growth seems assured by its possession of the major Soviet supplies of accessible power and most useful minerals, by fast improving communications and agricultural expansion, and perhaps also because it lay entirely beyond the reach of the German invasion.

RICHARD J. HOUK—*São Tomé and Príncipe: a Geographic Appraisal*

The small islands of São Tomé and Príncipe, lying approximately 125 miles off the African coast, have received scant international attention in recent years. Yet these volcanic islands, first sighted by the Portuguese navigators in 1471–72, were occupied and colonized so rapidly that as long ago as 1522 they were regally proclaimed a Portuguese province. When first settled by the Portuguese, a tropical rain forest covered two unpopulated equatorial islands; their subsequent development clearly reflects the cyclical character of their international importance.

Because of their location, São Tomé and Príncipe first assumed strategic significance as way-stations for revictualing and repair of the great Portuguese fleets bound for and

from eastern Africa, India, and the Far East. Later, the European colonists utilized slave labor from the African mainland to develop plantation agriculture. Immediately sugar cane became so profitable that its cultivation once gave Príncipe a population of 50,000—in contrast to the present 7,000! Coffee later became such a boom crop that there were savage struggles for ownership of the best land. Cacao, first introduced as an ornamental shrub, found such a favorable environment that by 1905 this tiny colony was the largest exporter of cacao in the entire world!

Today, these insular territories of Portugal have lost most of their economic importance and all strategic significance. They do, however, possess a certain value by reflecting the transitory inter-relationship of geographic and historic factors in the development of the various political units comprising Africa, truly today's "continent in transition."

JAMES M. HUNTER—*Examination of a Concept Basic in Ratzel's Methodology of Political Geography: The State Is a Spiritual Moral Organism*

The organic theory of state growth and development from the biological viewpoint has been proved false and unusable in geographic methodology. When this theory was utilized in actual implementation, as the motivating idea for the internal and external division of state policy, it led to disastrous results. Many geographers recognize the theory in connection with the works of Kjellen and Haushofer. Others still maintain that Ratzel promulgated this concept. There is little doubt that Kjellen and Haushofer held the viewpoint that the state can be compared with a biological organism. This paper will, however, demonstrate that Ratzel held a different concept: that the state is "a spiritual moral organism."

The concept expressed by Ratzel that a state is a spiritual moral organism will be analyzed and briefly traced. The similarity between the Ratzel concept and ideas from Plato and Ritter will be stressed. Further, it will be suggested that the philosophical influence of Kant and Rousseau on Ritter and von Humboldt is traceable to Ratzel directly, and through the influence of Comte. It will be suggested that the concept of the world as a unit, held by von Humboldt and Ritter, was further developed by Ritter when he called each continent "a natural Whole," and finally Ratzel developed the theory one step further in referring to the state, a unit, as a spiritual moral organism.

It is concluded in this introductory study that Ratzel's work held a philosophical rather than a biological view of the term "organism."

HAROLD R. IMUS—*Projecting Sales Potentials for Department Stores in Regional Shopping Centers*

Since 1948 the planned regional shopping center has had a tremendous influence on the nature of commercial development in both suburban and retail core locations in American cities. By definition, regional shopping centers contain major department store facilities, usually branches of parent organizations located in the retail core of the city.

The opening of a major department store in a suburban location has serious implications for the parent store because of branch capital costs and impact on the parent store's sales, on company prestige and position with respect to competitiors, on management and staff requirements, and similar factors. For different reasons shopping center owners are also concerned because of the effect of the department store on project costs, drawing power and resulting sales and rents from tenants other than the department store itself, traffic and parking requirements, project size, arrangement of stores in the project and use of adjacent land adjoining the project itself.

Because of the necessity for sound planning, both department store and project managements depend heavily upon market analysis of sales potentials for advice as to store size, sales volume, opening date, and related matters. Basically involved in projection of department store sales potentials are:

(1) Determination of project trading area
(2) Population and growth characteristics
(3) Income and expenditure characteristics
(4) The effect of downtown and suburban competition, both present and future
(5) The department store's position and corporate image in the area
(6) Management attitudes

This paper discusses the data, methods, judgments, and philosophy of projecting department store sales potentials based on the foregoing concepts.

HILDEGARD BINDER JOHNSON—*Transfer of Private Land to Public Ownership in the Whitewater Valley in Southeastern Minnesota*

The establishment of the Whitewater Wildlife Refuge necessitates the transfer of privately owned agricultural land to public ownership. The original plan for the acquisition of around 22,000 acres was enlarged in 1947 to 55,000 acres. By 1956 the state had purchased with federal assistance roundly 22,000 acres, located largely in the main valley but also scattered along the tributaries of the Whitewater River. Warranty deeds and abstracts of title in the State Auditor's office identify 21,933.59 acres, for which $645,788.95 had been paid by August 18, 1957. This legal material represents a valuable and most accurate source of information for historical geography.

The investigation of this recent stage in the sequent occupance of the Whitewater watershed results in the following findings:

1. The project is handled prudently with great regard for biological principles and disregard of geographic ones.
2. The areal delineation of the whole project and the location of purchased lands are not likely to result in the rehabilitation of the larger Whitewater drainage basin.
3. The process of purchasing land and the management of the purchased tracts for wildlife purposes generate forces which re-affect the conditions under which the process can continue.
4. These locally generated forces are accompanied by developments on the regional and national scale which make the re-examination of the whole project advisable before it has attained 50 percent of its contemplated size.
5. The total cost of transferring privately owned land to public ownership cannot be accurately assessed.

ROBERT O. JOHNSRUD—*Guided Economic Change in a Northern Nigerian Agricultural Community*

In contrast with numerous studies in Africa of large-scale agricultural development projects, few geographers have examined the actual impact of processes of economic change on a specific underdeveloped area where local participation in general postwar economic growth has been accompanied by government and private efforts to increase production of specific crops without greatly modifying indigenous farming systems. In Gombe Division, in the savanna belt of northeastern Nigeria, export cotton production expanded in the decade 1948–58 from nothing to 14,500 tons (13 percent of Nigeria's total), representing a cash income in 1958 of $2,500,000 for the area's 150,000 peasant farmers.

Within the Gombe area, soils and rainfall are suitable for cotton, native varieties have long been grown, land is relatively plentiful, and both the local Moslim Emir and his farmers have been amenable to such innovations as improved cotton varieties and, to a lesser degree, bulls and plows. Government and private cotton organizations have cooperated to (1) distribute free cotton seed of a type superior to local strains, (2) provide a system of government-regulated and price-standardized cotton markets, (3) improve both local cotton evacuation and interprovincial railhead roads, and (4) post an agricultural extension officer in Gombe to supervise cotton seed distribution, manage a demonstration farm, initiate legal regulations, and discuss agricultural improvement methods with farmers.

Experience in Gombe indicates that cooperative government and private efforts *can* successfully promote cash cropping within traditional systems if (1) marketing and transportation facilities are provided, (2) innovations are demonstrably superior to old methods, (3) natural resources are suitable, (4) local cultural characteristics are relatively facilitative, and (5) agricultural extension work is continuous and attuned to local physical and cultural needs.

GEORGE H. KAKIUCHI AND SETSUTARO MURAKAMI—*Ōchō Village: A Study on the Specialized Use of Slopes in Southwestern Japan*

One of the common characteristics associated with Japanese villages having excessive amounts of sloping land has been poverty. Furthermore, without good paddy lands, the farmers had little hope of bettering themselves. But today, one can see some of the former poor villages showing a degree of well-being.

Ōchō Village was one of those which overcame the handicap of having excessive amounts of steep land by becoming highly specialized in the cultivation of mandarin oranges, a cash crop which could be adapted to the slopes.

Ōchō is located on one of the many hilly islands in the Inland Sea. The climate is relatively mild and the region is well protected from strong winds by the surrounding mountain ranges. Thus, the environment is suited to the growing of mandarin oranges.

However, Ōchō suffers from being on a small island and being located further away from the major urban areas—namely the Osaka-Kobe and the Tokyo-Yokohama conurbations—than Wakayama and Shizuoka prefectures, the two large mandarin orange producers. In order to compensate for the above disadvantages, the Ōchō farmers have emphasized the cultivation of the out-of-season varieties.

The efforts of the villages were successful, and although the acreage decreased during World War II, today mandarin oranges occupy over 90 percent of the total cultivated acreage of Ōchō.

What made possible the transformation of Ōchō from a poor to a relatively prosperous village was the economic development of Japan after the Meiji Restoration (1868). The rise of new industries and cities created new or increased demands for specialized agricultural crops. Ōchō was one of many which benefited from changing times.

P. PRASAD KARAN—*India-China Boundary Problems in the Himalayas*

The India-China boundary illustrates the concept that smooth functioning of an international boundary depends as much on the general political climate, attitude, and policy of the states involved as on the details of delimitation and demarcation. Through centuries the undemarcated India-China boundary following (for the most part) the crest of the Great Himalayan Range has remained stable; traders and pilgrims crossed the frontier without obstacles. Since the Communist occupation (1951) of Tibet, trade and pilgrimage across the boundary have been steadily whittled away; now the border has been practically closed as the People's Army is conducting operations against rebels. Thus the boundary has ceased to function smoothly because of a new political situation in Tibet, and, backed by militant Red China, the traditional barrier role of the Himalayan frontier has changed.

The boundary is defined in general terms in the treaties with Tibet. China refuses to recognize these treaties and the Chinese and Soviet maps show considerable areas of India's territory in Assam, Uttar Pradesh, and Kashmir within China. Recently parts of these areas have been occupied by Chinese troops in small skirmishes with Indian border patrols. Possibly the chief aim of China in challenging the Indian border defined in treaties and firmly established by custom and usage is to impress the world that China is stronger than India and can revise a frontier which was established without Chinese consent by the "British policy of aggression against Tibet." It seems the Himalayan boundary problems will continue to disturb relations between the two great Asian nations.

YUZURU KATO—*New Concepts: Population Distance and Transportation Density*

The objective of this paper is to introduce two new concepts that will be helpful for a better understanding of land transportation.

The degree of land transportation development has been represented numerically in two basic ways: the ratio between railroads (or roads) and population, and the ratio between railroads and area. If the ratios are to represent the degree of transportation service provided, the former gives too low a value where population density is high and too high a value where population density is low. The latter gives the reverse results. This is because population density is neglected in the two ratios.

The author proposes the following as an index of the degree of transportation service provided:

$$K = \frac{\frac{L}{P}}{d} \qquad \left(d = \sqrt{\frac{A}{P}} \right)$$

where K=proposed index
L=length of railroads (or roads)
P=population
d=population distance
A=area

Population distance is a new concept. However, it is nothing but another expression of population density. Population density represents the degree of population distribution viewed in terms of the number of people in a unit area if the population were evenly distributed. Population distance represents the same thing viewed in terms of the distance of two people if the population were evenly distributed. The concept that is represented by the proposed index will be called *transportation density.*

The values of transportation density of railroads and roads respectively have been calculated and mapped for the countries of the world and are to be compared with the values that are derived from the two conventional ratios.

JAMES B. KENYON—*Freight Transportation Trends Associated with the Suburbanization of Industry: An Example from the Paterson-Passaic District of New Jersey*

The substantial growth of industry in the suburban periphery of the New York Metropolitan Area has been accompanied by significant shifts in freight transportation within the area. Not only has the over-all pattern of points of origin and destination of freight changed, but so too have the proportions of the total handled by the different transport modes.

In this paper, aggregate figures are presented showing the distribution of areas of origin and destination of freight shipments to and from the Paterson-Passaic District of New Jersey. The heavy dependence of this district upon the commercial center of Manhattan is evident, as is the strong degree of industrial interdependence of plants in northern New Jersey. The fact that the district as a whole draws most of its supplies from and sends most of its output to places within ten northeastern states, and the fact that over one-third of its output moves to buyers within the New York Metropolitan Area indicate its regional sphere and market orientation.

The use of the motor truck has been greatly facilitated in the new location, both in terms of easier access to major traffic arteries and of more efficient docking facilities. Rail service, while in general decline among industrial plants, has become more specialized in its utility. The need for rail sidings has not declined, since virtually every new plant of relatively large size is provided with sidings. Inbound shipments, particularly of bulk commodities, continue to be made predominantly by rail. It is clear that the transportation considerations of accessibility to major arteries and of speed of delivery are of continuing importance as factors of industrial localization.

YING-CHENG KIANG—*The Climate for Growing Wheat in China*

China is a leading country for producing wheat. Most of the wheat produced in China is winter wheat from the districts south of the Great Wall in China Proper. Chinese districts north of the Great Wall, such as Manchuria plains, southern Inner Mongolia, and Sinkiang oases, produce chiefly spring wheat. The boundary between these two different wheat areas coincides with an isotherm of an average winter temperature of –3 degrees C. In China's winter wheat belt, more wheat is produced from the districts north of the Yangtze River, where the annual rainfall is less than 45 inches, or the mean yearly temperature is less than 17 degrees C.

The minimum amount of precipitation required for growing spring or winter wheat in China without extensive irrigation is 10 inches per year, or 8 inches during the growing season. The minimum heat requirement is a mean summer temperature of above 14.5 degrees C. This isotherm corresponds with a Remainder Index of 1,670 degrees C. The Remainder Index is a summation of all daily positive temperatures above the established zero of vital temperature, which, according to J. B. Kincer, is 6 degrees C.

The correlation coefficients between the yields of wheat from Chinese farms and climatic elements, such as rainfall and mean temperatures during the year, the growing season, or the two pre-harvesting months, are insignificant or even contradictory, ranging from 0.359 to –0.172. However, climagraphs show that more high yields were reported from those Chinese counties where the rainfall and mean temperatures during the above-mentioned periods are not extreme but moderate.

EUGENE C. KIRCHHERR—*Changing Pattern of Airport Land Use in the Chicago Metropolitan Area*: 1927–1956

As part of an investigation of airport land use and planning in the Chicago Metropolitan Area, a study was made of changes in the number and distribution of airports. A sequence of maps is the basis for describing and analyzing trends in the pattern of airports during four periods, viz., 1925–31, 1932–41, 1942–51, and 1952–56.

The establishment of commercial airports was not common until after 1925. With the expansion of urbanized areas, some of the origional installations were replaced by other forms of land use, and new airfields, in general, were located beyond the urban fringe. Thus, from 1927 to 1956, the mean distance of all airports from the central city (Chicago) increased from 19 to 26.5 miles. Other variations in the airport pattern are perceived through an analysis of changes in the number of airfields in concentric zones (at ten-mile intervals) centered on the Chicago CBD; of particular interest in recent years has been a marked abandonment of airports in the 10–20 mile zone, but an increase in the 20–30 mile zone. However, the general outward migration of the airport function has been partially offset by the establishment of three postwar airports close to centers of population and industry.

In recent years, the number of general aviation (private) airports has decreased, despite the greater number of aircraft and pilots. This emphasizes the need for a program of regional airport planning to provide facilities for all forms of air transportation in a metropolitan area.

HUEY LOUIS KOSTANICK—*Poland—Dominant Personality of Eastern Europe*

The postwar period has produced profound alterations in Poland's demographic structure and economy. These have resulted not only from changes of territory but also from internal population movements and from the Polish Communist system, as well as from general demographic and economic shifts which are taking place in all of Eastern Europe.

Although ethnic minorities in prewar Poland constituted one-third of the population, Poland is now preponderantly homogeneous. A massive resettlement program has transferred people from the eastern territories to the new lands. There has also been a marked movement to the western lands from the overpopulated areas of central Poland. A strong urban movement is also noted in relation to a major shift in occupation from agriculture to industry.

These multiferous currents of movement have produced differentiations in geographical distribution of population and significant sociological problems related to the mixing of people from different regions and with different social patterns.

Poland's economy has also been altered by territorial additions, and by implementation of new government policies. In industry, increased production is associated not only with the annexation of existing industry in the former German territories but also creation of new industrial capacity in all parts of Poland. The face of agriculture has similarly been changed by government policies of confiscation of lands and creation of a new structure of private farms, collectives, state farms (P.G.R.), and machine tractor stations (P.O.M.)

These territorial, demographic, economic, and political changes in Poland have created a new regional power alignment wherein Poland has become both politically and economically the dominant personality in Eastern Europe.

EARL E. LACKEY—*Nomographic and Machine Method for Assessing Daily Minimum Temperature Frequencies*

The daily minimum temperatures for any winter month for North America may be determined quickly by use of a nomograph when only the mean daily minimum temperature, the extreme minimum, and the extreme maximum are available. The effectiveness of the method rests on the persistent patterns of frequency distribution when the records are converted to normalized 100-scales.

The varying asymmetry of converted daily minima is closely associated with a characteristic frequency distribution. The method does not involve the separate evaluation of the numerous variables, but it does assume that all the variables are inherent in the record, and that the nomograph provides a synthesis which is adequate for most purposes.

The fixed values on the nomograph may be

expressed in tabular form, thus expediting the processing of the essential data. Moreover, these fixed values may be entered on machine punch cards and then the probable daily minimum for any winter month may be quickly found by giving the machine the three items of essential data (daily mean, extreme minimum, and extreme maximum), and wired instructions for sorting the deck of punched cards.

From the processed data, maps of North America may be constructed featuring the percentage of the time for any winter month that any given minimum daily temperature may be expected or, conversely, the minimum daily temperature that may be expected any given percentage of the time.

The nomograph has also been constructed to assess daily minimum temperatures in days per month instead of percentages.

JAMES F. LAHEY—*Validity of Mean Autumn 300mb Winds Associated with the Jet Stream over North America*

Upper level winds are typically reduced to seasonal normals. Variation in the mean autumn jet over North America makes this technique dubious.

During September and October the jet arcs from the northern Great Lakes through its core in Nova Scotia. Contrasted to this early mid-autumn position the November jet extends from Texas through its core in the southeastern states, thence through Nova Scotia. This positional shift is accomplished by increasing jet velocity.

Further analysis was done by computing the E–W and N–S components of the daily geostrophic wind. From these, means were computed for zonal and meridional flow for components from the four cardinal directions. Percentage frequencies for N, S, E, W, no E–W, and no N–S components were also computed.

Based on the calculations are these conclusions: Seasonal and monthly velocities at a point vary by as much as eleven meters per second.

West zonal flow is persistent. September and November west components are 250 times as frequent as east in the jet core. This figure drops to 60 in October. Hence, mean jet speed is 3.5 percent smaller than west zonal wind speed during October but the two are equivalent in September and November.

Meridional component is variable. In no instance was northerly or southerly component more than 2-plus times more frequent than its opposite component. Hence, monthly meridional flow values are 8 to 47 percent of northerly or southerly components. Thus, northerly and southerly components should be considered separately within months.

TREVOR LLOYD—*The Cooperative Movement and Danish Agriculture*

Denmark appears to the casual eye of the visitor as a compact and efficient agricultural community. There is little unused or waste land; farm buildings, dairies and packing plants are well kept, and persons engaged in farming are hard-working, well-informed and business-like. Only a study of national statistics reveals that agriculture as a source of livelihood is less important than industry, that agriculture provides a living for about one quarter of the population while industry, building, engineering, and transport are together almost twice as significant. Nevertheless Danish rural life made an indelible mark on the past national character and even today few Danes are far removed from contact with the land, however urban their lives may be.

The original natural endowment of Denmark by way of soil and climate was not exceptional. In fact, a century ago much of the land, particularly in western Jutland, was of little agricultural use. In addition, the loss of Slesvig and Holstein in 1864 aggravated the situation.

Since the 1870's there has been a transformation of Danish agriculture. This was due to the opening of new grain-producing areas in North America and elsewhere; intensification of the use of available land by improved techniques; reclamation of heaths, bogs, and shallow inlets of the sea; restoration of Slesvig after World War I; invention of machinery for dairying and other agriculture; rapid population growth in nearby industrialized nations; and industrial expansion within Denmark.

However, present Danish agriculture is largely a product of the effectiveness of the cooperative movement. This was introduced in the 1870's and grew rapidly. Within a generation it became a diverse but highly efficient

means for thousands of owner-farmers with small holdings to sell their products in the world market at competitive prices and still maintain remarkably high standards of quality.

The economic significance of the cooperative societies has been appreciated widely. What is less apparent is that through the cooperatives the principles of economic democracy were practiced throughout Denmark long before the population as a whole achieved political democracy. The creation of this agricultural cooperative movement was due to particular local circumstances—social, economic, and cultural—being in force at a certain time. Its success is reflected today in the Danish landscape and in the character of the whole nation.

ARTHUR F. LOEBEN—*Land Use Changes and Development at Five Closely Spaced Interchanges of the Pennsylvania Turnpike Located in Montgomery County, Pennsylvania —a Part of the Philadelphia Metropolitan Area*

The planned Interstate Highway System will require 287 interchanges with existing highways in Pennsylvania. Each interchange will have some effect on land use at the site and development in the area around it. Yet, the impact will vary, depending upon the site, position, forces of regional development, and the frequency of such interchanges. The interaction of these forces has been studied at five existing interchanges to help in planning for the impact of those to come.

There are five interchanges of the Pennsylvania Turnpike in Montgomery County, northwest of Philadelphia. One attracted developments of all kinds almost immediately, and its impact is expanding. Another is like a lonely outpost; there has been no development at the site. The third has attracted a prosperous industrial park and a cross expressway. The fourth is a special-purpose type, where a branch of the system joins the main road of the turnpike. At the fifth there is a crossing with a U. S. highway and modest development has occurred.

The five interchanges are located in the shape of a "T." Four are on that portion of the turnpike which is a circumferential around Philadelphia—the top of the "T." The fifth is on a northeast branch of the turnpike—the stem of the "T." All five are under the influence of commuter, interstate, intrastate, and local travel, as well as the crest of the expanding "urban-fringe." One interchange has truly become a "hub." Its impact has been impressive and is continuing.

FRED LUKERMANN—*The Concept of Location in Classical Geography*

The analytic concept "location" is one of the least defined terms in the vocabulary of geographical studies. Methodological writers have taken the word as given, or, recognizing its equivocal character, have begged to discuss it at a later date. Perhaps its meaning can be made clearer in the context of a more primitive usage—classical geography.

Location was used to describe relationship, quality, process. It was the philosophical "where." The studies in which the concept had greatest application were: geography, chorography, topography. Three questions arise: Was the concept used in the Greek studies? If yes, did the Latin word correctly transliterate the Greek word expressing the concept? Does present usage comprehend the Latin/Greek? The answers are no; furthermore, the Greek studies in which the concept was once integral have lost their specific and original meanings.

Geography was defined as the demarcation of the earth's surface by physical processes of world-wide pervasiveness, i.e., geographic location was referent to natural process.

Chorography was defined as the description of *given* areas, i.e., chorographic location was referent to the total relational content *within* the given area.

Topography was defined as the order of discrete units one to the other, i.e., topographic location was referent to the contiguity of places.

In that contemporary studies have inherited a "confusion of tongues," the vocabulary of location—place, space, region, area—has ceased to give definition, and the once sharpest tool of the geographic method—relative location—has become a methodological orphan.

PAUL E. LYDOLPH—*USSR Chemical Industries*

Capital investment in the chemical industries in the USSR during the period 1959–65

is to be about 525 percent of that during 1952–58. This compares with 245 percent for ferrous metallurgy, 240 percent for oil and gas industries, and smaller increases for other industries. Thus, it is apparent that during the seven-year-plan period the big "push" is on chemicals. Total volume of chemical production is to nearly triple. The production of artificial fibers is to increase four times; that of plastics and tars, seven times; and of mineral fertilizers, nearly three times.

This expansion is in response to acute demands from practically all sectors of the economy, particularly demands of the people for adequate supplies of consumer items.

The new chemical base is to be natural and by-product gas, which is to be produced on a scale that will allow for both the anticipated expansion of chemical production and a shift away from present production of ethyl alcohol from grain and potatoes. Many of the new chemical plants will be located in gas-producing and oil-refining areas.

The paper shows the distribution of the various chemical industries and relates the distribution to basic raw materials and market areas. An attempt is made to estimate the effects the development of a variety of products made from plastics and synthetics will have on standards of living.

VINCENT H. MALMSTRÖM—*Patterns of Circulation in Norway*

In few countries of the world has the development of an integrated and efficient transportation system been as arduous and costly as it has in Norway. Relatively great distances, coupled with mountainous terrain and a rigorous subarctic climate have confronted Norway's small and scattered population with difficult problems of inter-communication, problems which have been further compounded by limited resources and a long history of political dependence.

Through the ages, the sea has served as a primary artery of movement, particularly in the west and north. Coastwise shipping continues to play an important role in the country's economy as is shown by an examination of *hurtigruten*, or the northern express route, and the inter-regional movement of tramp ships. Overland routes, some of which have been in use since the Stone Age, began to assume a major importance only after the general adoption of wheeled vehicles in the 17th and 18th centuries. The evolution of the road net is traced cartographically and the present character and extent of road services are discussed. Similarly, the growth of the railway net is surveyed and regional patterns of passenger and freight movement are analyzed. Finally, the rapid postwar expansion of Norway's air service is assessed.

Throughout Norwegian development, improvements in circulation have been influenced as often by social and political considerations as they have by economic ones. As an example all present forms of public transport are operated with some degree of state subsidization.

GEOFFREY J. MARTIN—*"The Law of Primate Cities" Re-examined*

Mark Jefferson, the widely known and highly respected chairman of the Geography Department at Ypsilanti from 1901 to 1939, presented a paper to the Association of American Geographers at Cambridge in 1938 entitled "The Law of Primate Cities." In his delivery Jefferson asserted that "a country's leading city is always disproportionately large and exceptionally expressive of national capacity and feeling." Jefferson arrived specifically at this conclusion after studying quantitatively and qualitatively city populations in over forty countries of the civilized world. He perceived a constantly recurring supereminence of primate cities over second cities—a repetitious occurrence which encouraged Jefferson to declare this relation had the status of law. Discussion and dispute followed, waging from the geographers' meeting to the pages of the London *Times*.

The purpose of this paper is to explain and re-evaluate Jefferson's law of primate cities. Primacy of the leading cities of many countries will be measured by Jefferson's proportion technique, and his culture measurement method will be employed to explain in part the formulation of his law. Primate city growth in the twenty years following 1938 renders valid Jefferson's "disproportionately large" clause, and the relevance of national expression to primate city is assayed.

The complete correspondence, notes, and works of Mark Jefferson have recently been

donated to the Department of Geography, Eastern Michigan University, a circumstance which alone makes possible accurate retrospective analyses and portrayals of his work.

MARION E. MARTS—*International Upstream–Downstream Problems: The Columbia River Example*

Optimal development of the large remaining hydropower potential of the Columbia River requires coordinated international development by Canada and the United States. Although such development is clearly in the interests of both nations, agreement on international development has not yet been achieved. The variety of factors accounting for the long delay illustrate how an international boundary creates many difficulties inhibiting coordinated development of an international resource.

Serious difficulties are created by domestic conflicts between institutions and levels of government, and uncertainty in domestic resource policies. Under these conditions, the attractiveness of alternative and intervening opportunities is enhanced, and sub-optimal developments are undertaken. The difficulties are heightened by disparate levels of development on opposite sides of the boundary and conflicts in regional and national objectives. These give rise to differences in value systems and in the accounting of benefits and costs.

In the face of these difficulties, establishment of formulae for international sharing of costs and distribution of benefits of a river development program becomes an intractable problem, and the political mechanism must be invoked to achieve solutions which in the domestic case would be more economically oriented.

HAROLD H. MCCARTY—*A System of County Income Estimation for Use in Economic Geography*

A need for data that will measure both the relative and absolute importance of economic activities in small areas has become apparent in economic geography. That function seems to be best performed by an income measure. For a general economic geography of the United States, those data should be made available for all of the individual counties and for all of the major categories of production activities.

Annual income estimates of the type desired are available for the various states, but not for individual counties. The problem is to develop a satisfactory method of allocating state totals for the various income categories to the individual counties of those states. Satisfactory county data that can be used for this purpose appear to be available from various reliable sources.

Regression analysis is used to test the validity of these "allocators," which are then applied, for demonstration purposes, to the state of Iowa. Results are mapped and are compared, cartographically and statistically, with estimates compiled by other, more laborious estimating procedures. Examples of the manner in which such materials might be used in the analytical phases of general economic geography are presented.

TOM L. MCKNIGHT—*Manufacturing in Arizona*

Since World War II the manufactural segment of the economy of Arizona has grown at a faster rate than the industrial expansion in any other state, save one. Today manufacturing contributes considerably more income to Arizona than do any of the state's four traditional economic mainstays—farming, ranching, mining, and tourism.

In order to determine the reasons behind this growth and the geographical characteristics of contemporary industry, every manufacturing firm in the state was contacted by mail questionnaire and/or personal interview. Useful answers were obtained from thirty-seven percent of the nine hundred manufacturers in the state. The data thus gathered were expanded and broadened by library research, field observations, and further interviews.

Factories are distributed sporadically over the state, with principal concentrations in the major cities. Phoenix contains approximately one-half the total, and Tucson has another one-fourth. The principal types of manufacturing represented include aircraft and missiles, electronic equipment and electrical machinery, food processing, apparel, and miscellaneous metal fabrication.

Arizona's attractions for industry are, in large measure, non-economic. In few other

areas is the matter of "purely personal choice" encountered so frequently as the chief locational factor. Another intangible of importance is the favorable nature of the two "climates," atmospheric and business. Traditional locational factors that play a major role include a supply of skilled or talented but usually non-unionized labor at moderate wage rates, "favorable" state tax laws, the availability of risk capital, and a growing local market.

JOHN J. MCMURRY — *Florida's "New" Gulf Shoreline*

A research project supported by the Office of Naval Research has enabled the author to classify most of Florida's Gulf coast on the basis of its physical characteristics. Mangrove, coquina, sand, mud, high and low energy, stable, emergent, submergent, and other types of shorelines have been delimited and described along a coast which to the casual observer might appear monotonously similar over most of its length. Such shorelines are the product of wind, current, wave, and other natural forces, and are susceptible to systematic, orderly research methodology.

The "new" shoreline is something else, however. In the period dating from the commencement of this project (1954) to the present time substantial sections of Florida's Gulf coast have been profoundly changed by another agency, man. Increasingly we have noted artificial islands of various kinds, fills, channels, and other alterations resulting from man's activity. Thus a "new" shoreline is rapidly emerging in localities from Naples in the south to Pensacola on the northwest extremity. The effects of physical forces, such as hurricane winds and high water, shore currents, and interrupted tidal prisms on "new" shorelines with elevations of three or four feet above mean tide level are subjects of conjecture and even alarm. In addition, destroyed wild life habitats, polluted and stagnated waters, and lost esthetic values are frequently attributes of the "new" shoreline.

It becomes apparent, then, that the "new" shoreline is often not equated with the public interest. It should be. And it appears that this is a field in which the geographer might well function most effectively in establishing guides or techniques for determining wherein lies the public's interest in this ramified situation.

ROBERT B. MCNEE—*Processes Creating Geographic Patterns in the Managerial Economy*

The purpose of this paper is to provide perspective for geographic studies of corporate regional systems by examining the geographically significant differences between *atomistic* production systems (small-scale, small-area, localized units linked geographically by transportation and independent marketing) and the newer *managerial production systems* (large-scale, large-area, multi-unit systems linked geographically not only by transportation and markets but also by the managerial organization and the regional planning of giant, semi-socialized corporations).

Managerial production differs from traditional atomistic production in at least four ways: (1) bureaucratic decisions in large corporations versus individualistic, market-tested decisions in small firms, (2) indeterminancy of managerial objectives in large firms versus relative clarity of objectives in small firms, (3) diffusion and complexity of socio-political pressures on large corporations versus the relative simplicity and clarity of socio-political pressures on small companies, and (4) the combined role of the external market and internal corporate regional planning in creating geographic patterns in managerial economies versus external price geography as a determinant of geographic patterns in atomistic economies.

The United States has a pluralistic economy, with varying proportions of atomistic production and managerial production in different areas. The two co-exist areally and interact spatially. Realistic geographic interpretations require the study of the geographic patterns created by each system and the processes by which the two systems spatially interact to produce the total geographic pattern of production. The geographic study of corporate regional systems is one small step toward such interpretation.

WILLIAM R. MEAD — *Finnish Problems of Settlement*

The settlement of Finland has been gov-

erned by its location in high latitudes and on the eastern marchlands of Europe. In general, it has been settled from south to north and from coast to interior. Growing archaeological evidence reveals the nature of prehistoric occupation while Finnish historians have traced subsequent expansion and retreat of settlement from taxation documents and church archives. As a part of Sweden, Finland shared in eighteenth-century legislation which called for the keeping of population records and of surveys of land taxation.

Increasingly intensive occupation of the land has taken place during the last century. This is a result of the development of domestic and overseas transport, transformation of forest values, amelioration of farming conditions, expansion of geological survey, and elimination of the age-old threat of famine. Also, the establishment of an independent republic in 1917 gave new impetus to a country where energies had been sapped in constitutional struggle with Russia and by a substantial emigration.

This entire development has taken place against a background of pioneering, not so much in new holdings as by the slow piecemeal addition of new farm land from forest, swamp, and waste. The process is traceable from decennial statistics, land reclamation bounties for smaller holdings, air photographs, and silvicultural surveys. Reclamation has continued in spite of the shift from a rural to an urban population concentration.

Finnish economy was severely disrupted by the wars of 1939–40 and 1941–44. Finland lost 12 percent of its land and 11 percent of its people were displaced. A decade of rural resettlement was accompanied by industrial adjustments resulting from the reparations program. Vigorous planning was necessitated with economic structural changes which caused controversy. Meanwhile, the country had inherent surfeits and deficiencies of resources, occupied an isolated world position, and had to be alert to the physical and political hazards of its marchland location.

Finland constantly balances its population and food supply. Plans for the intensification of farming parallel forecasts of calorie needs. Also, population distribution is uneven. Peninsular or southwestern Finland has about half of the national population in a quarter of the total area and an increasing concentration, especially of industrial workers. Contrastingly, the country's northeastern third is under-developed. Heavy investment there reflects the need for planned exploitation of all Finnish resources. Subsidies have been made to attract people to and retain them in the under-developed region although some similar grants have failed in the skerry zone.

Finland is an illustration of the significance of national self-determination. Individual and national resolution has been a primary incentive for economic, political, and social improvement in spite of certain adverse characteristics of the natural environment.

MARY MEGEE—*Measuring the Industrial Character of an Area*

The measurement of the industrial character of an area is usually based upon an analysis of facts from statistics regarding volume of business, employment, capital investment, market area, and amount of dependence upon foreign sources for raw materials.

There has been a world-wide increase in manufacturing since World War II. There have been few analyses of the industrial characters of large urban regions.

The purposes of this study are to make known the availability of some reliable, current data for use in analyzing industrial characters of areas; to apply a statistical technique to these data for a large Latin American city; and to indicate the industrial character of this city.

Monterrey, Mexico, a city of 520,000, was selected for the study. A sample of the manufacturing industries was taken; and conclusions are presented.

PEVERIL MEIGS—*Some Geographic Factors in the Peloponnesian War*

Thucydides' classic masterpiece, written about 400 B.C. describing the great war between Athens and Sparta, has been exhaustively analyzed from the historical viewpoint. The present paper analyzes it from the geographical and, especially, the climatological viewpoint. Thucydides frequently mentions the military role of geographic factors, secondary though these often are to non-geographic factors of number and skill of men, politics, poor judgment, treachery, and bribery.

Certain natural phenomena, like earthquakes, had weight only because of popular superstition associated with them. An eclipse of the moon touched off the destruction of the Athenian navy and army at Syracuse and paved the way for disintegration of the Athenian Empire.

Among climatic factors of direct importance the seasons provided a central rhythm. During the wet, chilly, windy winter months people usually stayed at home; normally campaigning began in spring and ended in late autumn. The environmental factor mentioned most often was visibility, usually in the form of darkness. In fact, poor visibility led to the writing of Thucydides' history: a night-time snowstorm helped the enemy capture a city; General Thucydides was blamed and was exiled for twenty years; he used this leisure for writing.

Terrain and brush sometimes were used for screening; forest fire was used to rout an army. Wind at sea, rain, mud, and river floods played vital parts. Dust, solar radiation, and drought are mentioned.

The environmental factors important in the Mediterranean phases of World War II were essentially those that had been critical in the fifth century B.C.

ALEXANDER MELAMID — *Settlements on Fire Island, N.Y.*

Fire Island is a narrow spit of land consisting of several parallel sand dunes off the Atlantic coast of Long Island. As there are no agricultural or commercial fishing activities, the pattern of its resort settlement should have been determined by travel time from New York City and urban centers on Long Island and the width of the island. Analysis of the number of residences reveals that the theoretical pattern is distorted by the incidence of past property rights. Travel time and past property rights, but not width of the island, subsequently reinforced by zoning laws have determined the character of the settlements. The height and width of ocean-front sand dunes, which give protection from hurricane waves, were not considered a location or zoning factor. Dunes were left to be eroded by occupation and passage of man and vehicles. For this reason expensive artificial ocean-front dune building has now to be undertaken to protect the existing settlements.

ALOYS A. MICHEL — *Canalization of the Moselle*

The Franco-German agreement to canalize the Moselle River, part of the October 1956 Saar settlement, is now being implemented. Of thirteen new barrages required between Thionville and Koblenz, eight are under construction. The project should be completed by 1963, permitting the use of 1500-metric-ton barges as far upstream as Metz, 270 kilometers from Koblenz. Thus the Rhine, already the major water transportation artery for the Common Market, will be supplemented by a canalized tributary reaching deep into northeastern France and offering a 50 percent reduction in freight costs for the exchange of Lorraine iron ore and Ruhr coke. Of even greater significance will be the effect on costs of carrying Lorraine's metallurgical products to ocean ports. Rotterdam, directly attainable by barge shipment, will gain an advantage over Antwerp and Dunkerque, whose connections with Lorraine are primarily by rail. Even Strasbourg will lose a large share of what was considered its economic hinterland before the re-emergence of "Frankenreich."

Within the Coal and Steel Community, the French position will be enhanced, a consideration which explains both German reluctance to support the canalization scheme and the fact that France is paying two-thirds of the $95 million project costs. Since Ruhr furnaces are largely independent of Lorraine ore, Germany's gains from the project will be confined to the 747 million kwh/year produced by the ten hydroelectric stations attached to the barrages. Luxembourg, whose railroads are bound to suffer from barge competition, will be partially compensated by a share of the electric power and by French assistance in electrifying these rail lines and in building a river-canal port. But despite the apparent one-sidedness of the project, if the economic homogeneity of the Common Market develops as is now foreseen, the benefits of lowered transportation costs should eventually accrue to all participants.

CLARENCE W. MINKEL — *The National Railroad Project of Venezuela*

On January 15, 1959, the Venezuelan government inaugurated the first line of a proposed national railroad system. The opening of the 108-mile line from Puerto Cabello to Barquisimeto was heralded as the beginning of a new era in the economic development of Venezuela. A short time later, a 17-mile line was put into operation in eastern Venezuela from the coal mines of Naricual to the port of Guanta on the Caribbean Sea. These two lines represent the first segments of a railroad network which is to cover 2,640 miles within the next twenty years, and possibly within only eight years.

In view of the almost universal decline of railroads as a means of transportation, the proposed $1,200,000 Venezuelan network is clearly a project which merits attention. It is the purpose of this paper to outline the railroad plan, the problems encountered to date, and factors relevant to the potential success or failure of the plan.

CHARLES C. MORRISON, JR.—*The Hackensack Meadows: A Metropolitan Frontier*

Within sight of the Empire State Building there are 15,000 acres of undeveloped tidal marsh known as the Hackensack Meadows. Pressures for utilization of this submarginal land are only now approaching an intensity sufficient to initiate a regional reclamation and development program.

Thick deposits of Wisconsin drift in the Meadows are overlain by varved glacial clays from glacial Lake Hackensack. Recent changes in sea level and the impact of drainage alterations have drastically changed the vegetation. Similarly, the rural scene that persisted when the Meadows were a major barrier to transportation gave way to pollution, dumps, pig farms, and objectionable industries after the marshes were breached by railroads providing access to New York City's hinterlands and suburbs. Limited access highways seeking open rights-of-way through an intensively developed urban landscape are now transecting the Meadows from north to south.

Sanitary landfilling is succeeding objectionable dump-filling reclamation but these methods are too slow and piecemeal for development of a land reserve of this size. Early reclamation efforts, using dikes, were only partially successful because technology and capitalization were inadequate and land economics did not warrant development. Since 1896 more than a dozen schemes have been proposed, without result. But recently, mounting pressures on urban land have precipitated formation of the Meadowlands Regional Development Agency. This agency, which, incidentally, is supervised by a geographer, appears to be an effective instrument to cope with the Meadows.

The Hackensack Meadows offer a unique opportunity for systematically developing a land reserve in the New York Metropolitan Region. Whether these marshes will be reclaimed for the benefit of future generations in an urban area that has serious shortages of recreational and open space, or whether they will be used largely for commerce and industry to the benefit of municipal tax structures remains to be seen.

ROBERT W. PEASE—*The Time Continuum of Geography in Modoc County, California*

A geographic study is never outdated when regarded as a portion or facet of the infinite time continuum of spatial relationships that is geography. The continuum for Modoc County in northeastern California is portrayed by a sequence of geographic reconstructions for selected time horizons.

The first reconstructions show the evolution of the physical landscape and emphasize the fact that present-day lava plateaus are but thin veneers of basalt over older lake fill which in turn was deposited in basins impounded behind ancient Miocene fault blocks. Pleistocene erosion and faulting have created Recent basins that leave these lava plains standing as low platforms.

Subsequent reconstructions involve white man's use of the county area and bring out three eras: (1) early transit wherein fur trappers, westward-moving wagon migrants, and California miners bound for Idaho crossed the volcanic tablelands in spite of hostile Amerind inhabitants; (2) initial White settlement, marked by the movement of livestock ranchers to upland ranges and hay-producing meadows where isolation produced self-sufficient economies; and (3) later settlement,

wherein better transportation made possible the export, in addition to cattle, of lumber and cultivated cash crops, thereby breaking down self-sufficiency and abetting urban settlement.

The future of the geographic time continuum will be molded by man's ingenuity acting within the framework of the physical setting. Today the livestock industry adjusts to range depletion, yet continues to expand. Better irrigation increases the farm resource. New urban impetus derives from recreation, light industries, and reactivation of the transit role by railroad and highway traffic.

ALLEN K. PHILBRICK—*Practical Suggestion for the More Systematic Construction of Regional Generalizations*

The purpose of this paper is to illustrate a method of the concurrent use of the two discrete types of regional analysis—homogeneous and focal — toward a more systematic construction of regional generalizations.

The geographer's dilemma is always the problem of "seeing the forest for the trees" and maintaining constant contact between both the general and the particular in regional generalizations simultaneously. The practical solution always lies in the use of an appropriate degree of generalization to suit a given scale of thought and of visual representation. At a scale of one to one we may all analyze the appearances of reality into appropriately generalized units of homogeneity and perceive how human beings within their respective areal organization of items in earth space have interconnected these bits of homogeneity focally.

At specifically more generalized successive scales of thought and of mapping, systematic employment of alternately homogeneous and focal type area analyses, each considered in the horizontal plane, creates a controlled layered model of what may be regarded as scale stages in the construction of regional generalization. If each stage is controlled as to type of regional analysis and fits, in degree of generalization or of detail, within the concept of preceding or succeeding stages considered in the vertical plane, the whole content of regional generalization at any degree of detail may be reviewed at will. The paper concludes with an example.

ROBERT D. PICKER—*Expansion of Soviet Ferrous Metallurgical Production — Evolution of the Third Metallurgical Base in Soviet Asia*

The Twenty-First Congress of the Communist Party set the stage for a tremendous Soviet economic and political propaganda effort. As part of its industrial growth, the Seven Year Plan for 1959–65 mentions certain "qualitative changes" in Soviet industrial structure, particularly the evolution of a third metallurgical base in Siberia and Kazakhstan.

The Siberian area stands as an industrial frontier along which the Soviet Union is extending its power into the heart of Asia. The importance of a third metallurgical base is an example of Soviet areal development to less-developed nations.

The role of heavy industry is elemental to Soviet society. According to the Seven Year Plan, by 1965 pig iron production will attain a level of between 65 and 75 million tons. This increase will be partly dependent upon the installation of new productive capacity of between 7.5 and 9 million tons in a third metallurgical base.

The exact dimensions of the third metallurgical base have never been officially defined. The metallurgical base will center upon the ferrous production of: (1) existing units of the Kuznetsk combine, (2) the Western Siberian plant (Stalinsk), under construction, (3) the Karaganda metallurgical plant (Tamir Tau), under construction, and (4) two plants planned for the Angara–Yenisei region (Taishet and Achinsk). This system of plants will rely upon Kuznetsk and Karaganda coking coals and iron ore supplied from Siberian sources. Presently Soviet planners must solve the problem of inadequate transport with relationship to iron ore sources, whether to utilize hydro power instead of coal as a source of heat in the Angara–Yenisei region, and an adequate supply of water for the Karaganda plant.

The evolution of a third metallurgical base represents a re-emphasis of Siberian industrial growth.

ALEX D. POLEZHAYEV—*Geography in Moscow State University*

Geography in the Soviet Union occupies a prominent position among the sciences. This

can be proved by the map showing the distribution of geographical centers and nuclei as well as their number.

Moscow State University is one of the most important geographical research and educational centers of the Soviet Union. To give some idea of the size of the department it will be enough to say that it occupies six stories of the main building situated on the Lenin Hills save the museum of soil studies, comprising four more floors. The department consists of 14 chairs, the interchair scientific cabinet of the historical geography, the rich geographic library having all foreign geographic publications in their native languages as well as translated into Russian. Besides, the department has 18 well-equipped laboratories, some 40 thematical chair laboratories, 4 research–training field centers in different parts of the country. It should be noted that the department takes an active part in numerous geographical complex expeditions all over the country. The permanent staff of the department consists of 450 persons, among them 29 professors; the total number of students is 1800, of graduates, 60.

The educational program of the department envisages a good grounding of students in geography as well as in other connected sciences. During the 5-year period of studies (more than 5000 hours) in the department, 21 percent of school-hours are devoted to general studies (not in the American meaning of the term), 23 percent to broad geographical subjects, 24 percent to special geographical subjects, and 32 percent to practical training and field trips.

Geography is very popular among Soviet youth; it will be enough to say that this year there were 4 claimants for each educational vacancy in the department.

There is a great demand for geographers in our country; for example, 44 percent of the graduating students of Moscow University are offered places in industrial enterprises, 31 percent in research and educational institutes, 13 percent in secondary schools, 12 percent in various state organizations.

PHILIP W. PORTER—*Does Geography Need a Social Physic?*

The concepts of *interactance* and *potential* are bones of considerable acrimonious contention between geographers and regional scientists. This paper steals the bones from the disputants long enough to determine whether or not there is enough meat on them to be of interest to the geographer. The notion of population potential as a continuous distribution, as summarized in the work of John Q. Stewart and William Warntz, is specifically considered, as is its appropriateness to the description and prediction of spatial variations in price.

One conclusion of this examination is that interactance and potential are *distal* (one-dimensional) concepts; they are *mensurative* techniques which give linear, not areal, generalizations about distributions. This places the regional scientist, in terms of his methodology, squarely between the statistically concerned economist or sociologist, who orders his data according to their magnitudes and whose generalizations are commonly *punctal* (non-dimensional), and the geographer whose generalizations are *areal* and whose technique is *enumerative*; that is, whose data are counted and ordered with respect to the areas which contain them. A second conclusion is that a measure of the influence of supply and demand which eliminates distance as a factor can be a better predictor of spatial variations in price than one which uses distance (potential) as the main criterion. A final conclusion is that social physics can be of inestimable value to geography, perhaps not as the source of a new methodology, but as a powerful stimulus to continued re-examination of those concepts and methods which are peculiar and appropriate to the field of geography.

NORMAN J. G. POUNDS — *Land Use in the Hungarian Plain*

Medieval records make it clear that much of the Hungarian Plain was at that time a well-wooded area, as the climate would suggest it should have been. The invasions, especially of Tartars and Turks, led to extensive destruction of this natural vegetation. Although there were fluctuations, the trend from the earlier Middle Ages until the 18th century was towards the creation of an artificial steppe. In the 19th century the regulation of rivers brought about a lowering of the hitherto shallow water table and thus intensified the steppe character of much of the region.

Since the Turkish expulsion, cultivation has been extended over much of the plain, and some areas have been reforested. Contemporary accounts yield a picture of the changing vegetation and land use. Within the last century the distribution of crop- and meadowland has changed in response partly to the changing physical conditions, partly to the growing market facilities. These changes are reviewed in the light of early maps, statistics, and travellers' descriptions. The paper ends with a study of land use, by crops, in 1940, and a generalized land-use map of 1958.

DAVID A. PRESTON—*Changes in British Investment in South America*

During the latter part of the nineteenth century and during the first two decades of the present century the economic development and expansion of many South American countries was financed largely by foreign capital, chiefly from the United Kingdom. The flow of foreign capital proceeded despite chronic political instability.

Contrary to the normal orientation of foreign investment in export industries, 79 percent of the United Kingdom's investment in South America in the second decade of this century was either in railroads or in state bonds. It was this orientation of British investment which caused it to suffer most severely in the period since 1945 when economic nationalism has caused many undertakings, particularly foreign-owned public-service monopolies, to be nationalized.

The postwar period has seen a renewal of foreign investment in a much wider field than previously and the suppliers of capital are themselves more varied than before, for reasons which are outlined. The political instability which has characterized the South American republics has been only slightly diminished but this has seemed to deter few investors. In this flow of new investment, however, the United Kingdom has been surpassed as a foreign investor not only by the United States but frequently by other European countries as well. Out of the 101 applications for foreign investment in Chile in 1954, only four were from the United Kingdom. Some reasons for this decline are discussed.

MERLE PRUNTY, JR. — *Impact of Imports on the Domestic Steel Market: The Case of Wire Products*

This discussion treats the effects of imports of steel wire products on the American market since World War II. Three "merchant products" derived from wire constitute the case: barbed wire, nails, woven-wire fence. Since barbed wire is not protected by tariffs whereas the other commodities are, some approximation of the effectiveness of the present tariff structure is possible.

European and Japanese steel companies began quantity exports of wire products after World War II. The American export market for these goods has virtually disappeared since then. By 1958–59, imports accounted for more than half U. S. consumption of barbed wire; imports were increasing at a steady rate. Woven fence and nail imports increased at enormous rates, portending acquisition of the bulk of their U. S. market by importers. Customs district data indicate greatest foreign penetration in the South Atlantic and Gulf regions.

Comparisons of foreign versus domestic wage rates, imported dockside versus domestic steel millside f.o.b. prices, and shipping rates on selected rail and water routes, indicate that importers have both absolute and relative price advantages from at least Omaha eastward. These advantages pertain throughout the Middle West *without* shipping via the St. Lawrence Seaway.

The following conclusions are reached: (1) current tariffs provide ineffective protection; (2) unless essentially prohibitive, increments to the tariffs would be ineffective; (3) high wage costs are the main factor behind the noncompetitive position of U. S. wire producers. In the long run, U. S.-owned steel wire mills may be compelled to migrate to cheaper labor areas in order to compete.

RICHARD R. RANDALL—*The Slovenes in Austria*

Although many of the minority problems that plagued Europe before World War II seem to have been drastically but effectively solved by forced migration, some minorities still present problems to their host countries. The Slovenes of southern Austria are one of these groups. Practically quiescent for a number of years, the issue of the Slovenes

arose again recently when Austria passed a law making bilingual (German–Slovene) education no longer compulsory but voluntary. Yugoslavia, which champions the cause of the Slovenes in Austria, and which feels that compulsory bilingual education is vital to the preservation of the Slovene minority, considers the action a step to denationalize the Slavic group—a policy it claims Austria has been pursuing for over a century. While making protests and taking minor counteraction, Yugoslavia at present can do little to force Austria to re-establish compulsory bilingual education. However, should Austria bring the case of South Tyrol before the UN, Yugoslavia would charge that Austria seeks more cultural freedom for a minority in another country but denies the same rights to a small linguistic group within its own borders. To avoid world criticism of its own minority policies, Austria may well decide to reinstate the compulsory bilingual education.

JACK C. RANSOME—*Location Research in a Supermarket Chain*

Few supermarket chains have research departments to formulate their past store location experience, and, with maps, evaluate new store proposals. In several companies, however, geographers head location research units. In one large chain, the real estate department contains location research and leasing sections.

The location research section does the following: (1) analyzes annually 250–300 new-store, remodel, or consolidation proposals as to location, site, trading area population and boundaries, competition vulnerability, company share of market and market growth; (2) surveys new territory to determine company entry, and, if facts are favorable, assembles a store program; (3) assists divisions to make master plans, educating them to use maps of company and competition customer distribution, population density, income, and highway changes; (4) prepares population and food sales projections; (5) reanalyzes each new project after the store has been open a year; (6) extracts from a universe of 1400 stores the repetitive patterns of location, facilities, and market characteristics which produce successful stores.

The location research section has refined the criteria for company entry into small towns. The effects of adding a second or third store in cities of 40,000–100,000 are thoroughly understood. Median company share by size of market has been determined.

Metropolitan regional studies reveal the per capita sales to be expected in each trading area distance zone of a supermarket. The proportion of customers derived from each zone is predictable, although it varies with type of store and associated retailing. Considerable success has been achieved in estimating the transfer of sales from one supermarket to another.

HERBERT L. RAU, JR.—*Electric Power Industry of East-Central Brazil*

East-central Brazil, including the states of São Paulo, Rio de Janeiro, and Minas Gerais, comprises half the population and two-thirds of the industry of Brazil. A rapid expansion of power plants has occurred since 1945 in this region, which has 70 percent of Brazilian total power. A description of principal companies and generating plants follows. Private power is dominant, but government projects have grown recently. Hydro power constitutes over 80 percent of the total, with thermal plants used in small installations and in low-water periods. Nine hundred and eighty-five stations are operating, most of them having less than 2,500 kilowatt capacity.

Transmission–distribution systems conform to the early concession areas, but integration is being attained within principal systems. Expansion of capacity has not equalled demands, and difficulties in obtaining capital and equipment increase with national insecurity. State and municipal companies are growing rapidly, with federal capital participation; World Bank or similar capital will be needed to meet the 1960 national goal of five million kilowatts.

The better hydropower sites have been utilized, generally close to the larger cities and the escarpment; however, not one-fourth of hydro potentials in the Plateau are developed. New projects are chiefly in larger watersheds lying west of present consumption centers. Although most of the power produced in these distant sites (such as Paulo Afonso, with 180,000 kilowatts) will be used in present consumption centers, some will be available

at the western margin of settlement. Population and certain industries may thus have further incentive to follow into the interior.

GORDON E. RECKORD AND CHARLES F. DAOUST — *Projection of Future Land Use — San Francisco Bay Area, 2020*

Geographers and other land-use specialists should be able to predict what use will be made of urban land in the future if their observations and conclusions on urban land-use practice in the past are valid. If the rate of change in land use is known, present use in a region can be extended in regular patterns to give a reasonable approximation of the pattern in the future. In a recent study of the San Francisco Bay Area and surrounding counties, techniques were developed for (1) projection of urban land use in six major categories over a period of sixty years, and (2) verification of the resulting pattern against projection of population and industrial employment in the region made by other means. The method used and described in the paper involved the application of widely used and generally accepted concepts of industrial, commercial, and residential use to land of such observed qualification as slope, drainage, and bearing capacity. The rates were determined by examination of local rates of change of use. The check on the intensity of use was provided by applying conversion factors for industrial and residential land to estimates of industrial employment and total population independently projected by statistical methods. The projection period extended to the year 2020; land-use maps for census decades accompany the paper.

WALTER W. RISTOW—*Aeronautical Charts—Fifty Years of Evolution*

Transportation maps are the most widely used cartographic tools. The improvement of man's means of mobility have, through the centuries, challenged and stimulated cartographers to devise and produce ever more specialized maps and charts.

The phenomenal development of aerial transportation, during the past half century, has presented unprecedented and complicated problems to map and chart makers.

How well they have met the challenge is related in this paper entitled "Aeronautical Charts—Fifty Years of Evolution."

WILLIAM C. ROBISON — *The Savannas of Virginia*

The pre-colonial vegetation of Virginia has often been interpreted as a forest interrupted by thousands of square miles of grassy savannas. An examination of historical sources suggests that some estimates of the former extent of grassland are excessive.

The evidence indicates that natural meadows were scattered in low areas along many of the streams at the eastern foot of the Blue Ridge, and in some of the periodically submerged bottomlands of the Tidewater region. In parts of the Tidewater and the Piedmont, and in a few mountain valleys, the Indians cleared land for cultivation of corn, but when abandoned these fields usually reverted to forest within a few years. The Indian practice of annually burning the woods often has been cited as responsible for the occurrence of widespread deforested areas. Yet there is no evidence that the Indians regularly burned any of the mountains, and such fires as they started in the valleys and the Piedmont were generally set in the course of localized fire-hunts rather than as part of a policy of indiscriminate burning. The claims of extensive deforestation of the Shenandoah Valley by the Indians are based largely on tradition and statements by historians who wrote, at the earliest, a century after the first settlement of the Valley. It is probable that there were some grassy plains along the lower Shenandoah but that forests were also common in the area.

Drainage of low areas, clearing for cultivation, grazing, fire, and abandonment of agricultural land have altered the former conditions to such an extent that the present vegetation gives little indication of the pre-colonial occurrence of savannas. On lands with moderate slope, and on some of the bottomlands, the former forest has given way to a man-made "pasture savanna" which is one of the most characteristic landscape types in present-day Virginia.

ROBERT D. RUDD—*Summer Frontal Precipitation in the Daf Climate Area of the United States*

Relatively few studies appear in the literature including percentages or actual amounts of precipitation classified as to cause or origin. A more complete understanding of climate, however, should be furthered by such data. The several variables to be considered make precise identification of many occurrences of precipitation difficult. This paper reports a study designed to indicate the *relative* importance of frontal precipitation in the Daf climate of the United States during the summer months.

Ten stations were selected from seven states within the area of Daf climate. Daily and hourly precipitation for the stations were considered in conjunction with Daily Weather Maps. Each occurrence of precipitation was classified by consideration of time of occurrence, its relation to areas of continuous precipitation, and relative positions of frontal systems. Classification employed two basic categories, frontal and other. Precipitation associated with fronts and cyclones shown on the surface synoptic chart was classified as frontal. Five years were considered, 1952 through 1956, and attention was focused on the warm season, June through September.

Data presented in the paper include percentages of warm season precipitation classified as frontal at each station for each year, the five-year average for each station, and the average of all stations for each year. Analysis of the precipitation occurrences included in this study suggests that frontal precipitation is dominant during the warm season in this area.

MILOS M. SEBOR — *Historico-geographic Aspects of Piracy*

The historically extinct and remote field of piracy is a testing ground for principles of geographic validity. It casts a sharper light on aggressiveness of cultures, on methods of the Commercial Revolution, overseas expansion, and imperial conflicts.

The definition would differ from the normative concept. For a geographer, only the sea robbery, noted for some type of organization, would be interesting. This restriction is still wide enough to include—speaking in terms of the time—pirates, corsairs, privateers, and semi-private adventurers, such as buccaneers.

Difficulty of approach arises from the contrast between the historical continuity of piracy and its geographic dismemberment. Historically, piracy appears as an inherent phenomenon in navigation from the earliest times, culminating during the period of the overseas expansion, and being practically extinguished in the twentieth century. The geographic approach is compartmental. It deals with piratic areas—Mediterranean, Red Sea, Persian Gulf, Madagascar, Malayan, Chinese, North Atlantic, and West Indian—which once affected the sea routes.

Demonstrated is the relationship between the efficiency of piratic operations and prosecution on the one hand, and the frequency of navigation, type of trade, configuration of the coasts, winds and currents, national origin of the adventurers and piratic tradition, and political intrigues of powers on the other hand.

Principles tested are: (1) universalism of the geographic field, (2) relevance for a geographer of a large-scale, man-induced plague, and (3) complexity of the Man–Nature relationship.

The record of the Caribbean reveals a bearing of piracy and its prosecution upon exploration, mapping, and settlement of the area—hence a positive contribution to expanding civilization.

THEODORE SHABAD—*Locational Factors in the Soviet Synthetic Rubber Industry*

Of all the great industrial nations of the world, the Soviet Union is most dependent on synthetic rubber. This reliance on the synthetic product results from the absence of domestic natural rubber sources and from a desire to assure self-sufficiency in strategic commodities.

Soviet synthetic rubber production began in 1932 on an industrial scale. The Lebedev process derived rubber from ethyl alcohol, distilled chiefly from potatoes. Since as much as 60 tons of potatoes were required for one ton of synthetic rubber, the first Soviet factories were located in the potato-growing zone of central European Russia.

A second process, based on limestone–calcium carbide–acetylene and requiring large

amounts of electric power, was started industrially in the late 1930's at Yerevan in Armenia, where both limestone and cheap hydroelectric power were available.

The recent rapid growth of Soviet petroleum and gas production is providing a new source of raw materials for making synthetic rubber. New rubber factories are being located near oil refineries to make use of waste gases. At the same time, oil and gas pipelines laid to the vicinity of the old rubber factories are changing the raw-material base of those installations.

The Russians are also beginning to make use of their vast wood resources as a basis for making synthetic rubber. The first Soviet rubber plant, deriving ethyl alcohol from the hydrolysis of cellulose, is operating at Krasnoyarsk in Siberia.

The Soviet drive for the use of new raw materials frees deficit potatoes and grain for livestock feed. The current campaign is also designed to reduce production costs of synthetic rubber and to bring Soviet technology closer to United States practices.

VINCENT K. SHAUDYS — *External Aspects of the Political Geography of Five Diminutive European States*

In spite of limited land areas, five political entities in Europe—Andorra, Liechtenstein, Monaco, San Marino, and Vatican City State —possess the essential elements of statehood and nationhood. Each occupies a portion of the earth's surface to which it can claim title and over which it has effective administrative authority. Besides providing for the internal administration of its territory, each of these states either conducts its own relations with other states, or by international agreement has voluntarily delegated these external functions inherent in sovereignty.

This paper examines the degree to which these five miniature entities can or cannot promote the welfare of their populations in relations with other states. Handicaps resulting from limited size may have forced these states to adopt practices which could be of value to larger political units. The analyses of these external functions in the context of current political behavior are classified as territorial, economic, political, and strategic. This is in accordance with the outline suggested by Professor Richard Hartshorne in his 1950 presidential address before the Association of American Geographers.

The inhabitants of these states enjoy a fairly high standard of living, close personal contact with their governments, freedom from military service and the direct costs of war, and little or no taxation. External economic and political pressure are a constant threat which they are unable to counteract effectively except by moral persuasion.

JOSEPH T. SINCLAIR—*Current Development of the Tourist Industry and Its Future in the Economy of El Salvador*

Until recently, only domestic tourism has been important in the tourist industry of El Salvador. There is as yet no satisfactory measurement of its international tourism, and the estimated five hundred tourists a year is high because many commercial travellers use tourist permits to avoid visa fees.

Potential income from tourism is important in El Salvador's future because the dense population already occupies a greater percentage of land than in other Latin American countries, leaving little room for agricultural growth. The lack of sufficient resources limits industrial growth.

When the National Tourist Board was started it was charged with the development of tourist sites based on geological phenomena, such as volcanoes, lakes, beaches, and mountains. Now that the Board has finished some of the roads, hotels, and restaurants needed, enough sites are considered developed to start promotion. Forty thousand dollars will be spent, starting in the fall of 1959, primarily in the United States.

Competition from Mexico and the other Central American republics must be met. In El Salvador's favor is its location as a junction for north–south and east–west airline traffic. It is also only thirty minutes by air from Guatemala City, tourist center of Central America.

In conclusion, the plans and development for tourism appear adequate. The geography of the country is interesting and accessible to the tourist. El Salvador is well located with respect to established transportation. The need to develop international tourism is evident. Conditions favor an important role for tourism in El Salvador's economic future.

HERBERT L. SLUTSKY — *Ecological Study of Total Mortality among Guatemalan Pre-school Children, with Special Emphasis on Protein Malnutrition and Kwashiorkor*

In protein malnutrition and kwashiorkor, the world is faced with a serious and difficult public health problem. Although global in extent, its prevalence varies regionally. An ecological study of this problem, i.e., collection of detailed information on the environmental elements and the organism, might provide clues for a more holistic explanation of why there are geographic variations in the incidence of these disorders.

A medical geographic investigation of protein malnutrition and kwashiorkor was conducted in Guatemala. It was demonstrated that there was a marked regional variation in the proportion of total mortality due to deaths among young children. A field study was undertaken to determine (1) whether there was a comparable regional variation in protein malnutrition, and (2) whether regional variations in the nutritional status of other environmental elements might contribute to the pattern of mortality. Ten villages and towns were selected at random, five of which were located in areas of high mortality and five in areas of low mortality. A nine-man research team performed physical examinations on 1,193 Indian and Ladino pre-school children and collected data on a variety of environmental elements.

The geographical pattern of mortality tended to coincide with the physical geography of Guatemala. A mortality rate between 70 and 90 percent of total deaths in the Coastal Lowlands occurred among pre-school children, whereas in the Central Highlands the mortality was 10 to 30 percent. The great difference in mortality appears to reflect an interaction of the environmental elements rather than protein malnutrition alone.

JOHN W. SNADEN—*Changing Patterns of Land Utilization in Cahokia, Illinois—the Residential Period, 1950–60*

Within the expanding St. Louis metropolitan region a number of areas have been bypassed in urban development and the land has been given over to uses other than those directly associated with urban development. Cahokia, Illinois, the oldest settlement in the metropolitan region, lying just south of East St. Louis and within sight of the St. Louis Central Business District, is such an area.

Prior to the period 1950–60 most of the land lying within Cahokia was given over to agricultural uses, although the village was dominated during the 1930's and 1940's by two large airports, one of which was closed in 1958 and the land subdivided for residential use. Changing land utilization from agricultural–airport uses to residential assumed increasing significance from 1950 onward.

The soggy flood plain of the Cahokia area was by-passed for residential use until more favored areas were settled. The flood plain, to a great extent, determines the nature of the residential use. Home construction is basically for the lowest possible cost, $8,000–$13,000. The homes are small, 900 to 1200 square feet, and the density is great. Assessed valuations are low and the lack of industrial or extensive commercial developments restricts the tax base.

Cahokia is thus an area of growing low-cost residential development of increasingly high density with a severely restricted tax base which limits the extension of urban services. Therefore, Cahokia represents a potentially depressed area in the metropolitan region of the future.

J. SONNENFELD — *The Function of Primitive Implements: a Study in Implement Geography*

Reconstructions of the subsistence relationships between primitive man and his environment have been handicapped by the difficulty of ascribing precise function to many of his tools, despite the fact that stone implements are among the best preserved of archaeological materials. Implement interpretations appearing in the literature have tended to be conjectural at best, and misleading at worst; most commonly they are merely descriptive.

To establish criteria for function-interpretation, various implements known only archaeologically have been tested and studied in the field and laboratory. Work so far has progressed along three main lines: (1) determination of the relationships between an implement's various gross dimensions in order to distinguish among stylistic, technological, and functional characteristics; (2) formulation of

tests, including the reconstruction and working of a variety of stone implements, in order to determine whether specific use produces marks or patterns of wear on the implement which may be considered unique according to function, and thus indicative of function; (3) study of the mechanics of wear to permit one to derive function of an implement by systematically distinguishing the way in which it was hafted and worked, and the material on which it was used.

Results so far have demonstrated the feasibility of this use-wear analysis approach to the solution of the problem of implement function.

HARISHANKAR P. SRIVASTAVA — *The India–China Boundary: a "Holding Line"*

With the "liberation" of Tibet by communist China, India now faces the problem of guarding effectively the longest border of any democracy with a communist state. The problem is all the more difficult when we consider the fact that even though this boundary is natural and for the most part clearly defined and delimited by conventions and agreements, it runs along the treacherous terrain of the Himalayas and is mostly undemarcated.

In two sectors — the northwest and the northeast—India comes in direct contact with communist China. In the central sector the three buffer states of Nepal, Sikkim, and Bhutan are sandwiched between the Tibet region of China on the north and India on the south. These states lie south of the main crest of the Himalayas and are oriented toward India by history, tradition, and culture.

A major portion of the northwestern boundary was defined by a treaty between the Rajah of Jammu and Kashmir and the Dalai Lama in 1842. The northeastern boundary, as far as India is concerned, is defined by the MacMahon line drawn on two maps in 1913 and initialed in 1914 by the British representative Sir Henry MacMahon and the then Prime Minister Lonchan Shalia of Tibet. Except at a few places, it follows the main crest of the Himalayas.

Chinese forces started infiltrating across the above two sections of the border only a few weeks after the treaty of friendship, putting forth the five principles of coexistence, was signed by India and China in April 1954. The Chinese completed a road in 1957 in the northeastern part of Ladakh, cutting across the Aksai Chin plateau. The Chinese governmen has repudiated the MacMahon line and has claimed about forty thousand square miles of Indian territory. Some Chinese maps showing this fact have assumed a sinister significance and cannot now be dismissed as mere cartographic aberration.

In this paper an attempt has been made to trace the historical evolution of the northern border of India and the present-day politico-geographic problems connected with it. It is the "holding line" against the infiltration of people and ideas from the communistic north.

KARL STACEY—*Energy Requirements of Japan, 1955–1975*

A sustained growth of industrial production in Japan of four percent per annum will require a corresponding increase in total energy. Projections of power and fuel requirements are analyzed, which show that some 250 million metric tons of coal equivalent will be required in 1975, compared with 109 million in 1955.

Possible limits of production from domestic reserves of coal, petroleum, and hydropower are presented. Trends in fuel-energy sources are described; a fourfold increase in both coal and petroleum imports is probable. Possible massive imports of liquefied natural gas (from Borneo–Sumatra) are considered, as well as discoveries of off-shore oil and gas fields in the Sea of Japan. Limitations of large-scale use of nuclear power are presented; these include socio-cultural factors, physical geographic factors, and economic factors. Nuclear electricity will not contribute very much before 1975 to total energy needs.

Alternatives to continued rapid increase of energy supply are these: governmental restriction of growth in "power-hog" industries, encouragement of rail and ship transport coupled with restriction on auto and truck movements, actual decrease in domestic uses of electricity to allow industrial expansion. None of these alternatives is digestible at present, yet a continuance of large fuel imports is dependent on an increasing export trade of manufactured goods. Any rapid increase in power costs for Japanese industry

will erode Japan's present low-cost advantage in world markets.

KIRK H. STONE—*Swedish Fringes of Settlement*

Useful guides for settlement planning may be obtained by the transfer of planned and unplanned settlement experiences between areas of comparability. Therefore, the fringe of settlement region in Sweden is classified in preparation for the transfer of positive and negative settlement experiences from Scandinavia to northern North America.

Basically the fringe of settlement region is the edge of the inhabited world. In the high latitudes it is usually between an unpopulated region to the north and a well-settled area to the south. The latter is defined as the region of continuous settlement. In Sweden this is the southern third of the country in which any settled point is within five kilometers (about 3 miles) of the nearest settled points in all directions. Persons living at these points are also not isolated with respect to transport; generally every place is within 10–15 miles of roads and railroads providing local and/or inter-regional transport in three or four widely divergent directions.

The fringe of settlement region is one of discontinuous population distribution. Locally, settlement may be continuous in linear and small areal patterns but many inhabited spots represent extreme local and regional isolation in distance from both nearest settlement and any form of transport. In Sweden this region is the country's northern two-thirds. The southern regional boundary is roughly 60°N. or about two-thirds of the way northward from Stockholm to Gävle.

The region is divisible into four fringe zones, in SW/NE bands, by variations in isolation, a major element in planning to assure permanence in existing or new settlement. The divisions are recognizable by the distribution and size of the uninhabited areas and the orientation, quality, density, and frequency of private use of or public service on the transport routes relieving regional and local isolation. When progressing from northernmost and westernmost Sweden toward the south and southeast, the zones are:

Zone & Type	*Degrees of Isolation*		*Average Swedish Size*
	Regional	*Local*	
Outermost Fringe zone Inland type	High	High	Three areas: SW/NE: 20, 50, 250 mi. SE/NW: 25, 25, 40–60 mi.
Outer Fringe zone Inland type	High and moderate	Moderate and high	One area: SW/NE: 450 mi. SE/NW: 30–50 mi.
Middle Fringe zone Inland type	Moderate	Moderate and low	One area: SW/NE: 500 mi. SE/NW: 40–90 mi.
Inner Fringe zone Inland or Coastal type	Low and moderate	Low and low	One area: SW/NE: 550 mi. SE/NW: N½ 30–50 mi. S½ 110–150 mi.

ROBERT N. TAAFFE—*Evolution of the Regional School in Soviet Geography*

Although recent discussions of Soviet geography in American journals have touched upon current ideological themes, little mention has been made of the origins of contemporary theoretical discussion. A survey of the evolution of the regional school in Soviet economic geography provides an essential framework for an analysis of the current concepts of Soviet geography.

The regional school has traditionally been led by the economic geographers of Moscow University, including Nikolai Baranskiy. In the 1920's, this school, relying heavily upon the concepts of Hettner, Weber, and Von Thunen, "decisively defeated" a systematic-statistical school in geography. The same period witnessed the expansion of the *landschaft* direction in physical geography under the leadership of Lev Berg, who also openly acknowledged his debt to Hettnerian concepts.

The regional and *landschaft* schools disavowed all "bourgeois influences" after being subjected to bitter attacks in the early 1930's. These attacks reflected the reaction against Weberian locational theories, which were used by opponents of the Urals–Kuznetsk Combine, and, more generally, a drive to "cleanse" Soviet science of the last remnants of "bourgeois" thinking. A "leftist" school then arose which attempted to make economic geography part of economics and also a "Party discipline."

The attacks on the regional and *landschaft* schools and their advocacy of a unified geography in the 1950's echoed the earlier objections. At present, the regional school does not regard itself as a school but as the dominant direction in Soviet economic geography, primarily because of the increased emphasis on

a regional approach in economic planning and administration.

EDWIN N. THOMAS — *Toward an Expanded Central Place Model*

The existence of two hierarchical systems is basic to the central place model. At the onset, it is hypothesized that cities in a group fall into discrete population-size classes which in turn are associated with similar distance classes.

The important notion being dealt with appears to be the existence of a systematic relationship between (1) the population size of the cities in the group and (2) the distance between them and their nearest neighbors with the same population. The use of these hierarchical systems is designed to provide a means of demonstrating this relationship.

If a relationship between the population size of a given city and its nearest neighbor with the same population size could be established without classification of the data, a more sophisticated central place model could be developed. Hence the purpose of this paper is twofold. First, a technique employing statistical probability concepts is presented by which urban places having the same population size as a given city may be selected. Second, an example is provided to show how the basic central place formulation can be expanded by treating distance between a given city and its nearest neighbor with the same population size as the dependent variable in a multiple-regression analysis.

Weaknesses and limitations in this regression model and in the technique for determining nearest neighbor with the same population size are discussed.

FRANK H. THOMAS — *Selected Commodity Flow Patterns of the Denver & Rio Grande Western Railroad*

The Denver & Rio Grande Western Railroad by virtue of its location offers an opportunity for examining railroad freight traffic subject to a minimum of competition from other railroads and yet serving nine different regions of Colorado and Utah. Two of the regions served include standard metropolitan areas and are essentially urbanized while the remaining seven are non-urbanized. An examination of seventeen selected individual commodity flow patterns results in preliminary findings threefold in nature:

(1) Flow patterns indicate areas of specialized production. Classification of flow patterns according to type of originating region (urbanized or non-urbanized) and type of destination (intra-hinterland or extra-hinterland) reveals aspects of the organizational structure of the railroad hinterland in terms of commodity markets. Furthermore, examination of important branch-line flows reveals a tendency for specialization in single-commodity traffic origination.

(2) Flow patterns of individual commodities exhibit the same characteristics of total railroad traffic flow described by William Wallace in his recent studies of freight traffic densities and patterns. Traffic volume increases with proximity to major cities and decreases with distance from these cities.

(3) Flow patterns suggest for testing hypotheses concerning railroad freight traffic generation: (a) Traffic originated by extractive types of economic activity is associated with non-urbanized regions. (b) Extractive commodity traffic origination is associated with specialized storage or processing facilities when commodity production is dispersed or with production areally restricted by natural resource occurrence (or irrigation). (c) The largest volumes of traffic are generated at places where concentrations of interdependent industries are found.

MORGAN D. THOMAS—*Industrial Linkages and Economic Development*

A salient characteristic of the contemporary scene is the great desire by most societies for greater prosperity as measured by a rise in the level of living. Today, to prosper means to become richer and richer. However, the possibility of continuous economic expansion may be questioned in terms of the availability of necessary kinds and amounts of resources, and more seriously in terms of society's ability to accept increasing rates of change in ways and conditions of life. Notwithstanding such misgivings, it is assumed that greater material wealth through economic growth will be pursued, for the next generation, by most technologically advanced and retarded economies.

In this paper, attention is focussed on tech-

nological linkages between industries, for these are powerful growth-inducing or retarding forces in any economy. A normative model is constructed to show the nature of forward and backward industrial linkages. The influences of a number of locational factors (such as labor, market, power, and transportation, within a particular area) on the construction of such a model are discussed. In addition, imports and exports and minimum economic size of plants in various industries are examined as factors which condition the nature of linkages in particular regions.

Industrial linkage analysis provides a device for use in the selection of industries which should act as "prime generators" of economic activity. These enterprises should receive initially the greatest attention and investment. The choice of "prime generators" is of paramount importance because it will condition the nature, direction, and rate of future economic changes.

JOHN THOMPSON—*Food Production for San Salvador, Republic of El Salvador*

San Salvador is outgrowing the long-established mechanisms which provide its supply of perishable food. The demands of a population developing in numbers and in aspirations, together with improved transportation and liberalized trade agreements, have extended the food supply area into adjoining republics.

At its simplest, the assembly of farm products is performed by *canasteras*, women who carry a basket or two of truck crops and/or poultry from home to market. Most complicated are the operations of the *toponeros*. They are male and female "wholesale" crop, livestock, or fish buyers who regularly canvass rural areas, usually specializing in one or two commodities. Most of the buyers operate on borrowed capital; their purchases are with cash. As a rule, *toponeros* also are retailers. Except for dry staples (maize, sorghum, beans, and rice) and sugar, there is little government control of food movement, quality, or price.

The mechanisms of crop and livestock production, assembly, and distribution are beginning to change significantly. The first producer cooperatives have been formed (dairy, truck, fish); modern processing and shipping facilities are operating (dairy, fish); new public markets are being built; a pasteurization law has been drawn up; and plans for a complete revision of the meat industry are receiving official consideration.

The changes occur as the government assumes responsibility for nutrition, public health, and rural improvement. Producers, especially the larger ones, foresee better earnings; consumers can hope for equitable prices and wholesome food. One development appears certain. San Salvador and the country have growing food requirements, which promise increased commerce for neighboring countries.

SIGURDUR THORARINSSON—*Geographical Changes in Icelandic Population*

Iceland is unique in being one of the larger inhabited areas where there was no primitive nation before the first white settlement. Thus, the country's settlement history is known from the beginning when Norwegians migrated to Iceland in the later 800's. Irish monks were there at least a century earlier and Roman ships had been there in the second half of the 3rd century A.D. but these did not result in permanent settlement.

By about 930 land acquisition by the first Scandinavian settlers was practically ended; population then probably was about 30,000. Towards the end of the 11th century there were 70,000–80,000 inhabitants. By that time settlement had expanded far inland towards the uninhabited center and many rural areas had population densities similar to those in Norway.

In 1703 the first thorough census of Iceland disclosed a decrease to 50,358 people. In 1801 it was 47,240 and the density was only a sixth of that in Norway. The inner Icelandic settlement limits had begun to retreat and there were changes in the structure of some of the settlements. The causes were climatic differences, glacial oscillations, volcanic activity, soil erosion, variations in oceanic currents, deteriorating communications with other countries, and the influence of the Danish trade monopoly.

Through Icelandic development there also have been variations in the size of the inhabitants. The heights of the males have varied from 172 cm. (about 68 in.) in the 11th cen-

tury to about 167 cm. (about 65¾ in.) in the 18th century to about 177 cm. (about 69¾ in.) now.

The present trend of population distribution is the depopulation of climatically ill-favored areas and accelerating urbanization. The latter has resulted in Reykjavik's growth to include about 40 percent of Iceland's 159,302 population in 1955.

PATRICK JOHN TYSON—*Winds and the Kinetic Theory of Gases*

The presently accepted explanation of winds and other atmospheric currents is that they are produced in response to differences in air pressure. This follows from the acceptance of the concepts of gases which treat the atmosphere as a continuous fluid. A more realistic view, however, is expressed in the kinetic theory of gases, in which air is considered to be composed largely of empty space in which tiny particles (molecules) are moving at considerable velocities. The dimensions of these molecules are many times smaller than the average distance between them. According to the kinetic theory of gases, differences and changes in air pressure may result from gross air movement, but in no way can they cause it. The causes of gross air movement are shown to be gravitation and centrifugal force acting upon differences in air density.

These differences in air density are by no means congruent with differences in air pressure. Differences in air density can and do exist without any corresponding difference in air pressure. Conversely, differences in air pressure can and do exist without any corresponding differences in air density.

The proof that differences in air density are the cause of winds and air currents is a simple one, and requires no mastery of either advanced mathematics or physics to follow the chain of reasoning.

Other applications of the kinetic theory of gases to problems in meteorology and climatology show promise of simplifying many of the problems which exist in these fields.

JOHN H. VANN—*The Mangrove Plant Community of the Guiana Coast of South America*

A strip of mangrove extends as a distinct belt along the north coast of South America between the mouth of the Orinoco and Oyapock rivers, and extends inland up-river well beyond the tidal limit. The arrangement of the mangrove belt along the streams, the segregation of species in belts along the coast, the distance the mangrove extends inland along the rivers, and the composition of the mangrove forest appear to be different along the Guiana Coast than elsewhere. This paper discusses the ecological reasons for these differences, and presents data and interpretations on the composition and structure of the Guiana mangrove forest. The Guiana mangroves are compared with those elsewhere in the world, and the mangrove formation is treated from a geographical point of view emphasizing physical and cultural relationships.

Some of the problems connected with the commercial development of mangrove lands are treated briefly.

CHARLES B. VARNEY — *Changing Importance of Florida's Tobacco Production in Agriculture*

This study examines the changing importance of tobacco produced in Florida in relation to the state and national agricultural economies and attempts to explain, in part, these fluctuations.

Of the twenty states listed by the USDA as commercial tobacco producers, only six exceed Florida in value of the crop produced.

About a million pounds of tobacco were produced in 1950 in Florida. There was a rapid increase of production to 1860, then a decline occasioned by the Civil War. With the introduction of flue-cured tobacco into north Florida in 1924 total acreage expanded to about 33,000 in the late thirties. Subsequently, total acreage has fluctuated between 22,000 and 30,000 but with a steady improvement in quality and value of the annual crop.

Tobacco in Florida in 1937 represented 2.68 percent of the state's total agricultural production, but this proportion more than doubled by 1949 to 5.66 percent. An increase of the percentage of the United States tobacco crop represented by Florida-grown tobacco from 1.062 percent in 1937 to 1.75 percent in 1949 indicates the growing importance of Florida as a tobacco producer.

Many complex factors will determine the future of Florida as a tobacco producer. For

instance, the inertia and reputation of her tobacco production coupled with the continuing, relatively inexpensive labor supply in her tobacco-producing areas should provide Florida a basis for slow but steady improvement as a tobacco producer in the national picture.

Finally, a formula (percent of Florida's total agricultural production represented by tobacco divided by the sum of the percent of the U. S. tobacco crop represented by Florida tobacco and the percent of total U. S. agricultural production represented by Florida tobacco) to produce an index of relative importance on a combined state–national basis will be used to illustrate comparison of Florida tobacco with that of other states.

JOSEPH VELIKONJA—*Industrial Diversification in the City of Chicago*

This paper presents an attempt to show how the method for measuring the industrial diversification of metropolitan areas as a whole, used by A. Rodgers, can be applied to smaller subareas taking the city of Chicago as an example. The 1958 employment data for larger manufacturing establishments were used. The areal units for which the diversification indices were tabulated are square-mile sections. The distribution of manufacturing employment by types of industries for the square-mile sections is compared with the diversified structure of the city as a whole. Refined indices show the deviations from the index for the city and emphasize the degree of specialization. The indices show the diversified or specialized character of the internal structure of subareas and indicates their relative values.

The method applied and areal units used provide a high degree of uniformity and eliminate the adjustments which are necessary if the areal units are of unequal size. The limitation of the method as applied in the study lies in using only data for major establishments. Total employment figures would provide a better base for tabulating the indices, reducing the range between the maximum and minimum values while still retaining the relative rank position of the areal units.

The distributional pattern of indices shows the predominance of diversified industries within the sections of the central and northern portion of the city while the predominance of specialized industries is evident in the south. The degree of specialization for the four major sections of the city increases progressively from north to south. The high indices of the south, indicative of specialization, are accounted for by the presence of huge manufacturing plants and only a few industrial categories. The greater diversification of the north is accounted for by the complex superimposition and cohesion of different industrial types and a general lack of extremely large establishments. It appears also that diversification is a function of employment size, namely, as employment increases, diversity increases and the index decreases. Square-mile sections possessing a single large establishment are noteworthy exceptions to this generalization.

The maps showing the degree of specialization or diversification by means of indices summarize and simplify the information which might be shown less clearly by locational dot maps or other cartographic presentations.

JACK RICHARD VILLMOW—*Industrialization in the German Democratic Republic*

An analysis of the present distribution of industry in the German Democratic Republic is made, based upon data from the 15 "Bezirke": Rostock, Schwerin, Neubrandenburg, Potsdam, Frankfurt, Cottbus, Magdeburg, Halle, Erfurt, Gera, Suhl, Dresden, Leipzig, Karl-Marx Stadt, and Berlin, democratic sector. The relative significance of these administrative units in terms of factory units, laborers, and production value is examined. Regional patterns in the four major industrial groupings — raw-material industries, metal-working industries, light industries, and food and luxury industries—are noted. Industrial types of major significance are studied in terms of regional importance; the dominance of the textile industry in the German Democratic Republic is emphasized; the importance of the other ranking industries — chemical, mining, electrical equipment, transport equipment, and machinery—is related to well-defined regional patterns. Trends in industrialization during the decade 1950–59 are noted.

WALTER PRESCOTT WEBB — *Three Geographical and Historical Concepts Essential to an Understanding of the American West*

In my work in history I have found it impossible to separate a civilization or culture from the physical foundation on which it rests, and in the American West the environment is an overwhelming force which has made man and his institutions bend to its imperious influence.

In making this approach I have developed two major concepts and a minor one which have enabled me to understand and to teach others to understand what has happened in the 17 western states; and why it happened.

The first concept, developed in *THE GREAT PLAINS, 1931*, is that of the stark contrast between the East and the West. The second concept, set forth in *Harper's*, "The American West — Perpetual Mirage," came more than twenty-five years later, illustrating how slowly concepts develop. While the first concept sought to explain what the people had to do to go West and stay, the second seeks to explain the pattern they formed after they arrived. This second concept holds that the character of the American West is determined by the great desert at its heart.

The third and minor concept has to do with a modification of the census divisions of the American West. The present divisions, so far as the West is concerned, are not in conformity with the facts as I see them. New divisions, conforming with geographic and historical facts, should be established. They would run north and south, the way things run in the American West.

GILBERT F. WHITE—*Water Supply as a Factor in Industrial Location*

Two contrasting views of the role of water supply in industrial location emerge from a recent review of geographical and engineering studies. In some quarters water supply of suitable quality is seen as a limiting factor on future industrial development. In other quarters it is viewed as a necessary material but one which can be so transported, stored, and treated as to make it of tertiary importance in the location of new industry. These views are examined by analysis of (1) national and regional trends in industrial water use in the United States, (2) the experience with water use and water cost in selected industrialized areas, and (3) the elements entering into decisions by selected managers in water-thirsty industries. As a means of gauging the degree to which water-saving is practiced and of assessing its relation to water surplus, a measure of physical efficiency of water use in industry is suggested and applied.

Some new views are offered as to the relation of water supply to plant location for each of the major groups of industrial users. Major exceptions to these formulations are noted and are explained in large part by the special character of water resource estimates, of technological change in water-saving devices, and of social constraints on water development.

ANTHONY V. WILLIAMS—*Economic Development in an Advanced Economy: the Case of South Wales*

Today, the term "economic development" is synonymous with the struggle of technically underdeveloped areas to increase real income per capita. However, the term also has a real relevance to advanced countries attempting to effect changes and improvements in their industrial structure. The examination of recent progress in one such area offers important highlights on methods of promoting economic development in diverse environments.

South Wales, over the period 1938–59, was chosen as the area of study. In the 1930's, this region suffered from many of the ailments common to underdeveloped economies, such as: (1) excessive dependence on one economic activity—coal mining, (2) large-scale visible unemployment combined with underemployment in many economic activities, (3) lack of employment opportunities for women, and (4) a sharp dichotomy between the hinterland and the larger coastal cities. In general, the above pattern no longer prevailed in the late 1950's.

The factors responsible for the transition to a more modern and diversified economy are similar to those proposed for developing technically backward nations today. They include massive government aid, both of an organizational and financial nature, a planned pattern of industrial location, and a substantial amount of technical and financial assistance from the United States.

Differences in local conditions make it dangerous to overgeneralize the relevance of the methods used in South Wales to achieve a higher level of economic development. Used with care, however, case studies such as this should provide insights into the problems of economic development now besetting Asian, African, and Latin American nations.

BERNT L. WILLS—*The Impact of Oil on the Williston Area of North Dakota*

Williams County, which includes most of the impact area, had a population increase of 26.8 percent in four years. Most of the population increase came from non-contiguous states, and resulted in a generally younger population. Many of the newcomers occupied trailers. There was a great increase in workers engaged in mining and constructions, service, and trade classifications.

Demand for housing outran supply, and all available space, including temporary structures, was pressed into service. Schools were clogged and put on shift bases; transportation and communication systems were strained; roads and highways suffered damages from the heavy traffic.

Criminal and immoral behavior did not develop to problem proportions; and little antipathy developed between "oldtimers" and "newcomers," even though the newcomers commonly held the better jobs and often differed in political and religious persuasion from the earlier residents.

Oil did not cause any political revolution. Some frictions and contentions arose among the higher echelons, particularly with regard to laws dealing with oil. Executives of the major oil producers were grafted on to the existing power structures within the local communities, thus adding a dynamic element.

Economically, oil discovery provided supplementary income for farm families, additional job opportunities, and a marked expansion in trade and service industries. In this industrial sector alone, service receipts for 1954 showed a gain of 226 percent over 1947.

The initial "boom" subsided and by 1955 conditions were stabilized but in the Williston Basin oil continues to be a sustaining factor in an altered economy.

WILLIAM A. WITHINGTON—*Urban Land Use in Southeast Asia: the Example of Medan, Indonesia*

Medan (population, 700,000) is the provincial capital of North Sumatra, the commercial center of the productive "East Coast" estate area, and probably the largest city of Indonesia outside Java. Its rectangular urban area, superimposed on an inverted "Y" of rivers, lies on an alluvial plain. Except for a few large offices, water tower, and spires of mosques or churches, Medan has a low tree-shaded silhouette of one- and two-story buildings.

Residential land, much of it peripheral, occupies broad areas. "Urban villages" (*kampongs*) of similar socio-cultural groups—Indonesian, Chinese, Indian, Western — predominate. A centrally located commercial district includes the principal market; large banks, estate and trading company offices; and much combined retail–residential land. Lesser market districts are at outlying highway foci. Government lands and offices, civil or military, are scattered throughout Medan. Focal transportational facilities include a sizable civil–military airport on the south; central railway yards; bus and truck depots; and several regional highways connecting to the basically rectangular street system. Large manufacturing plants generally have peripheral sites on transportation arteries, while small-scale industries lie within commercial districts. Schools, religious lands, hospitals, and consulates, each with little apparent pattern, occupy decreasing amounts of Medan's urban space.

Problems of land use in Medan arise from the pressure of a tenfold population growth since 1930, the intermixture of varied patterns of urban development, and the city's increased importance as pre-eminent regional center of North Sumatra within the largest and most populous nation of Southeast Asia.

LAURENCE G. WOLF — *Comparison of the Idealized and the Composite Distribution of Climates*

The diagram of the idealized distribution of climates has been compared to the distribution of the Koeppen climatic types using a composite method. Total extent of land has been determined for each latitude, mapped on

a Mollweide projection, and placed symmetrically with respect to the central meridian, thus creating a composite continent. The Koeppen climates have been grouped in the same way as on the idealized diagram, and the extent of their occurrence determined for each latitude. They have been located on the composite continent so as to reflect as well as possible their coastal or interior location on the actual continents.

Four differences are especially noticeable when the two diagrams are compared. In comparison with the idealized diagram, the composite diagram shows: (1) the bulk of the land in the low latitudes is Aw, B, or C, rather than Af; (2) the B climates occupy a greater proportion of the interior of the continents; (3) the D climates have a more southerly location on the eastern side of the continent; and (4) the E climates extend farther south on both coasts in the northern hemisphere. Generally speaking, the two diagrams are in agreement.

WILLIAM C. WONDERS — *Winter Roads in Northwest Canada*

Length of the winter season is a serious limitation on the economic development of the Mackenzie Valley area of northwest Canada, as in other northern regions. Stockpiling over the summer is an expensive though standard practice. Air transportation costs have been prohibitive for many commodities. "Cat trains" (diesel tractors and attached sleds) have provided overland transport in winter to some centers, but use of this technique has declined in the area in recent years.

Winter roads for use by wheeled vehicles have been reported in common usage in parts of the Soviet North. In the Mackenzie Valley area they have tended to displace the "cat train" in the postwar years. This paper examines this development and attempts to assess some of the critical factors involved in this type of transport which frequently is neglected in studies of northern transportation.

REVIEW ARTICLES

SPATIAL STRUCTURE OF THE ECONOMY: III

Publications reviewed:

Industrial Complex Analysis and Regional Development, by Walter Isard, Eugene W. Schooler, and Thomas Vietorisz. Cambridge: Technology Press of the Massachusetts Institute of Technology; New York: John Wiley and Sons, Inc., 1959. xvii and 294 pp. $8.75.

Location Factors in the Petrochemical Industry, by Walter Isard and Eugene W. Schooler. Washington: U.S. Department of Commerce, 1955. vi and 102 pp. $3.00.

The Location of the Synthetic-Fiber Industry, by Joseph Airov. Cambridge: Technology Press of the Massachusetts Institute of Technology; New York: John Wiley and Sons, Inc., 1959. xii and 203 pp. $9.75.

Allocation in Space, by Louis Lefeber. Amsterdam: North-Holland Publishing Company, 1958. xv and 151 pp. 17 guilders.

Part I of this essay reviewed certain general approaches to an understanding of the spatial structure of the economy by summarizing and comparing six recent books on the subject (see *Annals*, Vol. 49 [1959] pp. 232–9). Part II of this essay presented one of the new tools, programming, in the kitbag of the analyst and reviewed five rather restricted problems of flows and locations (see *Annals*, Vol. 49 [1959], pp. 471–82). Part III, the present and final part of the essay, will present certain recent trends in regional analysis. We will be concerned with interrelations of economic activities within and among regions. Certain problems related to those discussed in Part II of this essay will receive cursory treatment before these regional problems are discussed. Several persons who commented on Part II of this essay expressed interest in additional problems at this level of generality; so the main threads of Part II of this essay will be pursued a bit further.

A note on the character of the essay may be useful. The essay has undertaken the hopelessly large task of capsulizing and commenting upon recent developments which assist in the analysis of the spatial structure of the economy. Excepting the books which were reviewed in Part I of this essay, recent additions to the literature have been articles or specialized monographs. Because it would be tedious and often repetitive to treat these works one at a time, certain problems were singled out for discussion in Part II of this essay and the organization around problems will be continued through Part III.

It also is proper to mention that this essay does not treat large blocks of recent materials which are pertinent to the study of the spatial structure of the economy. Some of these are omitted because they are either well known or readily available to workers in geography. They include Professor Edward Ullman's studies of commodity flows and other studies of the geography of transportation, Dr. William Warntz's studies of potentials, studies of resource evaluation and of central place theory, and the bulk of the work on migration, circulation, and diffusion at the Royal University of Lund. Statistical problems of data collection, organization, and model verification are also deliberately omitted from the essay. This important subject is too large for inclusion here.

As mentioned before, five rather restrictive problems were discussed in Part II of this essay. Four more problems will be capsulized very briefly here, and major attention will be devoted to a tenth problem. As mentioned before, this is the analysis of interrelated economic activities and consequent regional interrelations. The several subtitles used when this problem is discussed—*Input-Output*, *Industrial Complex Analysis*, etc.—are alternate methods of treating this problem.

FOUR ADDITIONAL PROBLEMS

The reader will recall the transportation problem discussed in Part II of this essay. This problem treats the pattern of flows over a network, with amounts to be shipped and received and costs of transportation given. This problem was augmented through a series of problems which dealt with location patterns of production and consumption and of plants or warehouses on the transportation network, subject to various resource, plant capacity, and demand constraints. Problems briefly identified below also may be thought of as extensions from problems in the transportation format. But instead of considering locational patterns such as those just mentioned, chief attention will be given to patterns of flows on

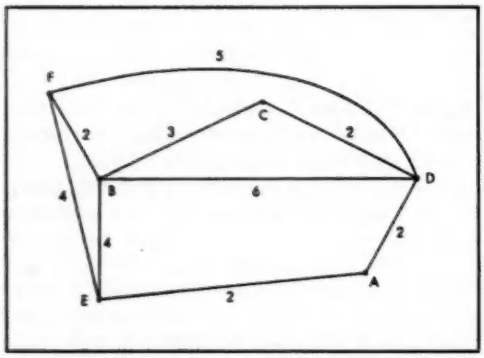

FIG. 1. Routes and Costs. Least-cost route from B to D is via C. From E to C the least-cost is via A and D.

the networks, subject to various constraining characteristics of networks.

1. *The Transshipment Problem.* This problem includes two considerations: one is finding the least-cost routes between places; the other is allocating shipments to routes so that total transportation costs are at a minimum. The term "transshipment" is used where a shipment moves from one place to another via an intermediate place. Alex Orden has found a very simple method of solving the transshipment problem.[1] Orden introduces artificial stockpiles at transshipment places. These greatly reduce the complexity of the problem and permit its treatment within a simple programming format.

Some expository discussion may clarify the problem. Suppose the transportation network has only direct routes between places. If this is the case, minimum cost routes between places are immediately known and the problem of assigning flows between places may be solved quickly by use of the transportation problem. But this may not be the case in some problems. A transportation network may offer a large number of alternate routes between places and the best solution of the problem may require shipping via intermediate places. In Figure 1, for example, one may ship from B to D either directly or via place C. The lowest cost solution would be via C. Some inspection will reveal that the cheapest route from E to C is via A and D. Here two transshipments are required. In a simple system like that in Figure 1 it is easy to locate least-cost routes. In more complex systems, such as the highway network of the United States, a lengthy inspection of alternate routes would be required to find least-cost routes. It is in cases such as this that Orden's solution of the problem is useful.

2. *The Traveling Salesman.*[2] The traveling salesman problem may be presented by asking how a salesman could begin at a city in one state, visit specified cities in 47 other states, and return to the origin in a manner that the shortest route is followed. One might begin at Albany, New York, for example. There are 47 remaining cities; so there are 47 choices for the first move. Select the next city and go there. The next choice is from among 48 – 2 cities (Fig. 2). It is easy to see that this problem involves (48 – 1)! choices, constrained by the condition that the tour end at the starting point. The problem is of much wider application than the finding of optimal salesmen's tours, of course.

In a sense this is a trivial problem. Note that there is a finite number of choices, so that all one needs to do is to list all alternates and select the shortest tour from among these alternates. From a practical point, though, this observation is not very helpful. Even in the rather simple case of a tour among 48 cities, there are (48 – 1)! or millions of alternates from which to select. The problem is not that of knowing how to find the solution. The problem is that of knowing how to find the solution easily. Most work has been done toward finding characteristics of optimum solutions (one of the few things known is that the optimum tour does not cross its own path) and in finding efficient computational algorithms (computing routines) for finding shortest tours.

3. *Max-Flow Min-Cut.* There is a well-known max-flow min-cut theorem which states

[1] Alex Orden, "The Transshipment Problem," *Management Science*, Vol. 2 (April, 1956), pp. 227–85.

[2] Merrill M. Flood, "The Traveling Salesman Problem," *Operations Research*, Vol. 4 (February, 1956), pp. 61–75; George Dantzig, R. Fulkerson, and S. Johnson, "Solution of a Large-Scale Traveling-Salesman Problem," *Journal of the Operations Research Society of America*, Vol. 2 (November, 1954), pp. 393–410; and "On a Linear-Programming, Combinatorial Approach to the Traveling-Salesman Problem," *Operations Research*, Vol. 7 (January–February, 1959), pp. 58–66.

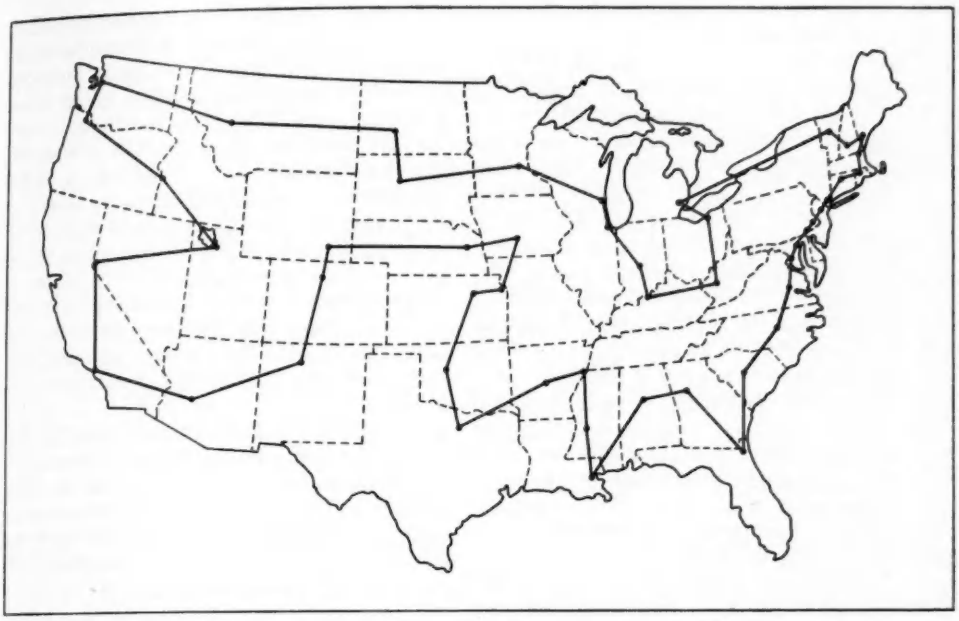

FIG. 2. Optimal tour among 48 cities. After Flood, p. 70.

that the maximum flow on a network is equal to the minimum cut. This requires some explanation. Imagine a network with a source and destination, connected by routes and nodes of varying capacity (Fig. 3). How much can flow in a unit of time between the sources and the destinations? Assuming an unlimited supply of goods to be shipped and unlimited demand, the flow is constrained by the capacity of the network. But how do we find the limiting capacity? We must look for "cuts," or bottlenecks, in the network. Technically, a cut is a collection of directed routes and intersections through which passes every route from source to destination. The notion of a cut is illustrated by Figure 3A: clearly the maximum flow from the source to the destination cannot be greater than the capacity of the node marked with the asterisk.

Dantzig and Fulkerson have developed a linear programming solution of the max-cut min-flow theorem.[3] The maximization side of the problem is the max-flow. The restraining equations locate the min-cut and the dual problem gives its capacity. Besides giving an extremely clear statement of the theorem, linear programming gives an efficient method of computing maximum flows and locating minimum cuts. This computational ease is important. In a complicated network, such as that in Figure 3B, it is by no means immediately apparent what the flow capacity of the network is nor where the minimum cut lies.

4. *Design of Networks.* A review of the literature will reveal that most analyses of communications systems are restricted to single links or intersections of networks. That is, design or use of a road is considered more or less in isolation from the network as a whole, or a railroad addition is considered in isolation from the network. The larger problem of the layout and use of an entire network is interesting for its own sake, and it may have practical values in underdeveloped areas or in the development of new networks in developed areas (e.g., the interstate highway system). Also, general models enable one to ask whether restricted objectives and

[3] G. B. Dantzig and D. R. Fulkerson, "On the Max-Flow Min-Cut Theorem of Networks," *Papers on Linear Inequalities and Related Systems* (Annals of Mathematics Studies, No. 38), H. W. Kuhn and A. W. Tucker, editors, 1956, pp. 215–21.

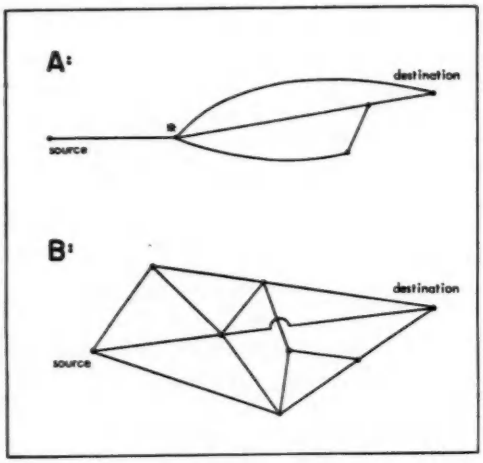

FIG. 3. Two Networks. It would be easy to determine the capacity of network A. Ability to compute min-cuts and max-flows assists the analysis of more complex networks, such as B.

decisions about parts of communications systems are consistent with objectives and decisions about entire networks. Works on the over-all characteristics of systems may be divided roughly into two types: (1) those that consider the routes and nodes of communications networks as given and involve decisions about increase (or decrease) of the capacity of individual routes or nodes, and (2) those that consider a network built from scratch or nearly so.

Kalaba and Juncosa[4] have written on the design and utilization of such networks as telephone systems. Here the problem is that of meeting some desired performance standard by increasing the capacity of switching points (nodes) and routes (lines) between switching points. Capacity costs are considered to be the only significant costs and the problem is to select from among alternative capacity costs that minimal investment which meets the desired level of performance. This problem may be handled nicely in a linear programming format, as may certain of the problems stated by Quandt.[5]

Quandt considers improvements in a network to provide capacity demanded by traffic at minimal cost. Quandt is able to formulate realistic programming problems in the rather restricted case when the total budget available for improvements is determined from outside the problem, say by the action of the legislature. When this is done, the dual programming problem gives an interpretation of interest rates and of the relative values of improvements at various places in the network. Quandt considers a transshipment case and the case where links between nodes may be added to the network. In this case combinatorial problems appear and computation may be difficult.

Quandt's and Kalaba's and Juncosa's models apply in cases such as highway or long-line telephone links in the U. S. where the basic outline of the pattern is shown. But even in such cases these models may not be completely applicable. Long-line telephone networks are gradually being replaced by microwave communication systems. Here one starts from scratch. New nodes (intersections or switching stations) may be created, as may links between these nodes.

Principles for the design of new networks have been treated recently by Beckmann[6] and Vadnal.[7] Beckmann considers cases of varying complexity. If the network is to be constructed to connect given nodes, the problem is that of choosing links and perhaps new nodes from among a large number of possible configurations. If three nodes are given, then a number of configurations of connecting links are possible, and some involve the creation of new intersections (Fig. 4).

Individual configurations may be analyzed without difficulty. But if it is necessary to choose among configurations and if this choice

[4] R. E. Kalaba and M. L. Juncosa, "Optimal Design and Utilization of Communication Networks," *Management Science*, Vol. 3 (October, 1956), pp. 33–44.

[5] Richard E. Quandt, "Models of Transportation and Optimal Network Construction," *Journal of Regional Science*, Vol. 2 (Spring, 1960), pp. 27–45. Another paper on this topic is D. R. Fulkerson, "Increasing the Capacity of a Network: The Parametric Budget Problem," *Management Science*, Vol. 5 (July, 1959), pp. 472–83.

[6] Martin Beckmann, "Principles of Optimum Location for a Transportation Network" (paper presented at the NAS-NRC Symposium on Quantitative Problems in Geography, 1960). Also, Martin Beckmann, "A Continuous Model of Transportation," *Econometrica*, Vol. 20 (October, 1952), pp. 643–60.

[7] A. Vadnal, "The Location of the Communication Network in a Circle" (paper given at the European Economic Congress, Bilbao, 1958).

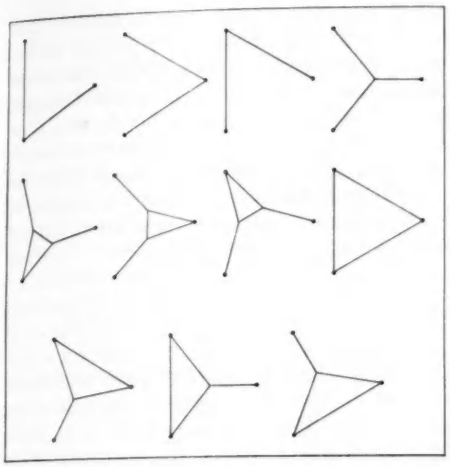

FIG. 4. Configurations of a network joining three points. The first three configurations in the first row are special cases of the fourth configuration. After Beckmann.

includes a large number of alternates, then analysis may be quite difficult. Suppose there are seven points, for example. There are many configurations to choose among. One set might be all those configurations presented by possibilities of joining three points in one subset of the network, four points in another, and then joining the two sub-networks. The large number of combinations possible leaves problems such as this fairly open, except in special cases.[8]

Beckmann considers a number of other cases, including the case of a continuously distributed population. He properly emphasizes that his models may be difficult to compute. However, if they are augmented by insight, judgment, and experience from outside the problem, they provide principles which may assist in the design of networks.

Vadnal treats the problem of the optimum pattern of a communications network within an economic area having the shape of a circle, with the network to provide transportation to the center of the circle. Vadnal shows how variations in the pattern of radials and circumferential routes will follow from different relations between over-the-road and capacity costs. Vadnal's model presents operational difficulties, but like Beckmann's it provides general principles which may be augmented by analytic devices and insight and is useful in understanding the layout of some types of transportation systems—urban freeways being a good example.

The problems described above are somewhat less than briefly capsulized. Nonetheless, the descriptions should give a glimpse of some systematic work on properties of some simple spatial patterns. This writer must again appeal to the reader's imagination. These four problems have many counterparts in everyday geographic analysis; they are ways of thinking about spatial patterns. The min-cut of a highway network and of the distributaries of a river are but two instances of a network property.

At this point we turn attention to the analysis of interrelated economic activities and consequent within- and among-region relationships.

INTERINDUSTRY AND INTERREGIONAL RELATIONSHIPS

Regional interrelations may be thought of as stemming from two conditions: (1) Uneven distribution of resources. Some regions are rich in resources and some are poor. Provided that demands for goods and services do not correspond with the distribution of resources, regions will be dependent upon each other for markets for their products and for sources of things that they consume. (2) A set of technical interrelations reflecting the technical state-of-the-arts. For example, the production of pig iron requires iron ore and coal, among other things. If pig iron is produced in one region and iron ore and coal are available only in other regions, then regional interrelations arise due to unequal resource distribution. But the unequal resource distribution results from raw material requirements of the industry which are a matter of the technical state-of-the-arts. Certain other interrelationships may be noted. Iron ore production may require coal. To produce the coal used to produce the iron ore used to produce the pig iron may require iron. So iron outputs flow to the coal-producing region and extra coal must be shipped to

[8] One exception is the special case of finding a route of minimum length. See William Miehle, "Link-Length Minimization in Networks," *Operations Research*, Vol. 6 (March–April, 1958), pp. 232–43.

produce this iron. The chain of technical interrelations never ends.

What has just been said is hardly new. What is new is that attempts have been made to attack problems of interdependences rather explicitly. Technical interrelations have been attacked at several levels. The level of generality represented by input-output is perhaps the one that has received the greatest amount of interest in recent years.

Input-Output

Suppose some information is available on interindustry interdependences. It will be convenient for the moment to think of industries lumped together at a point, so that there is no companion problem of interregional relations based on interindustry relations and differences in regional supplies and demands. It would then be possible to write down the interindustry flows or interrelations for n industries in a system of simple equations (1):

$$\begin{aligned} x_{11} + x_{12} + \ldots + x_{1n} + C_1 &= X_1 \\ x_{21} + x_{22} + \ldots + x_{2n} + C_2 &= X_2 \\ \vdots \qquad\qquad \vdots \qquad &\vdots \\ x_{n1} + x_{n2} + \ldots + x_{nn} + C_n &= X_n \end{aligned} \qquad (1)$$

This shows flows. C_i is the flow to final consumption from the ith industry and X_i is the total production of the industry. Reading across the row represented by the first equation, for example, indicates that the total output of industry 1 is equal to the amount produced for final consumption, C_1, plus amounts used up by other industries, such as the amount x_{12} which industry 1 ships to industry 2. The amount of its own product that industry 1 consumes is indicated by x_{11}.

The first equation shows the disposition of the products of industry 1, the *outputs*. The first column shows the *inputs* to industry 1. Industry 1 uses an amount x_{11} of its own product, an amount x_{21} of the products of industry 2, and so on. In general, x_{ij} is the output of the ith industry that goes to the jth industry and is, at the same time, the input to the jth industry from the ith industry. No statement has been made regarding the units of the data. There is some flexibility available, but in practice entries are made in monetary units.

For the unit of time and level of output for which they are collected, data of this sort give a useful picture of the complex of interindustry flows in an economy. Arranged in the form of equations (1) the data are of limited use as an analytic device for the study of changes. However, coefficients (Leontief input-output coefficients) may be computed from the data and the equations arranged into an analytic device as follows:

$$a_{ij} = \frac{x_{ij}}{X_j} \qquad \text{or} \qquad X_j a_{ij} = x_{ij} \qquad (2)$$

Economists have much to say about these coefficients. Their computation requires rather rigid assumptions about economies of scale. But this is another topic. The assumption does allow the equations of (1) to be written as equations (3) by carrying out the substitution defined by equation (2):

$$\begin{aligned} X_1 a_{11} + X_2 a_{12} + \ldots + X_n a_{1n} + C_1 &= X_1 \\ \vdots \qquad\qquad \vdots \qquad &\vdots \\ X_1 a_{n1} + X_2 a_{n2} + \ldots + X_n a_{nn} + C_n &= X_n \end{aligned}$$

or

$$\begin{aligned} (1 - a_{11})X_1 - a_{12}X_2 - \ldots - \quad a_{1n}\ X_n &= C_1 \\ \vdots \qquad\qquad \vdots \qquad &\vdots \\ -a_{n1}\ X_1 - a_{n2}X_2 - \ldots + (1 - a_{nn})X_n &= C_n \end{aligned} \qquad (3)$$

Equations (3) represent the economy in a manner susceptible to analytic work. A point that is very often of interest is how the economy would react given a new set of final demands, the C's. Such questions may be answered from equations (3). The a's of equations (3) are known numbers as are the C's. There are n X_i's which are unknown and there are n equations. In this case it would be expected that the n equations can be solved for the n unknowns by algebraic methods. Once the X_i's are known they can be converted back into the x_{ij}'s of equation (1) via equation (2).

Several interesting problems have been attacked using the notions described very briefly above. A word of caution about this brief description is warranted before going on to some of these. This is a very brief sketch of a subject on which books have

been written.[9] While the brief sketch will suffice for the purposes of this review, the reader should note that this essay has passed over problems of industry definition, obtaining data, what happens if the *C*'s are also unknowns, inclusion of households and imports and exports, and other topics. It would be wise to consult standard sources before using these notes beyond the context of this essay.

1. *Single Region Studies.* No one has set down material for a world input-output study, but several studies have been done for nations and a number have been done for smaller areas. Actually, these studies might be thought of as two-region studies. In almost every case the demands, indicated as *C*'s in equations (1) and (3), are given from outside the model. Some of these demands originate within the region and others originate from the rest of the world. The two regions are not exclusive areas, of course.

The first large-scale study was the 1947 interindustry study of the U. S. economy.[10] Interindustry flow information was obtained and a final table prepared for about 200 industries. There were smaller studies of the economy prior to the 1947 study and small-scale studies of other nations have been done since the 1947 U. S. study.[11]

The flow data from these studies are of great value. They give a glimpse of a structure of industry within nations. Also, enough information has been developed to allow comparisons of interindustry structures from nation to nation.[12] The national studies also provide methods of studying the reactions of national economies to demands made upon their productive capacity. Subject to uncertainties regarding the stability of the input-output coefficients, it is possible to postulate different levels and structures of demands and examine resulting interindustry gross outputs and changes in interindustry requirements.

Studies have been done for areas smaller than nations. These include regions, states, and urban areas. There is available, for example, a study of Utah versus the rest of the world.[13] Regional studies may be made simply to identify the structure of regional activities or as a basis for speculating on the effect of the growth of demands outside the region on industries within the region. Questions of the following sort may be treated. It is known

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[9] A bibliography of input-output studies is available in Vera Riley and Robert L. Allen, *Interindustry Economic Studies: A Comprehensive Bibliography on Interindustry Research* (Baltimore: Johns Hopkins University Press, 1955). Two basic books are Wassily W. Leontief, *The Structure of the American Economy 1919–1939* (New York: Oxford University Press, 1951), and Wassily W. Leontief *et al., Studies in the Structure of the American Economy* (New York: Oxford University Press, 1953). Good statements of the nature of input-output analysis are given in Robert Dorfman "The Nature and Significance of Input-Output," *Review of Economics and Statistics*, Vol. 36 (May, 1954), pp. 121–33, and Hollis B. Chenery and Paul G. Clark, *Interindustry Analysis* (New York: John Wiley and Sons, 1959).

[10] W. Duane Evans and Marvin Hoffenberg, "The Interindustry Relations Study for 1947," *Review of Economics and Statistics*, Vol. 34 (May, 1952), pp. 97–142. Bureau of Labor Statistics, U. S. Department of Labor, *General Explanations of the 200 Sector Tables: The 1947 Interindustry Relations Study*, March, 1953.

[11] A number of these are discussed in Tibor Barna (ed.), *The Structural Interdependence of the Economy* (New York: John Wiley and Sons, *ca.* 1955). Additional references are in Richard Stone, *Social Accounts at the Regional Level: A Survey* (Cambridge: Department of Economics, April, 1960), mimeographed, and Hollis B. Chenery and Tsunehiko Watanabe, "International Comparisons of the Structure of Production," *Econometrica*, Vol. 26 (October, 1958), pp. 487–521.

[12] Chenery and Watanabe, *op. cit.*

[13] Frederick T. Moore and James W. Petersen, "Regional Analysis: An Interindustry Model of Utah," *Review of Economics and Statistics*, Vol. 37 (November, 1955), pp. 368–83. Other studies are Werner Z. Hirsch, "An Application of Area Input-Output Analysis," *Papers and Proceedings*, Regional Science Association, Vol. 5 (1959), pp. 217–35, and *Fore*industry Relations of a Metropolitan Area," *Review of Economics and Statistics*, Vol. 41 (November, 1959), pp. 360–9; Irving Hoch, "A Comparison of Alternative Inter-Industry Forecasts for the Chicago Region," *Papers and Proceedings*, Regional Science Association, Vol. 5 (1959), pp. 217–35 and *Forecasting Economic Activity in the Chicago Region: A Progress Report* and *Final Report* (Chicago Area Transportation Study, 1957 and 1959); Guy Freutel "The Eighth District Balance of Trade," *Monthly Review*, Federal Reserve Bank of St. Louis, Vol. 34 (June, 1952), pp. 69–78; *A Regional Interindustry Study of Maryland* (Bureau of Business Research, University of Maryland, 1954); C. D. Kirksey, *An Interindustry Study of the Sabine-Neches Area of Texas* (Bureau of Business Research, University of Texas, 1959); and Roland Artle, *Studies in the Structure of the Stockholm Economy* (Stockholm: Stockholm School of Economics, Business Research Institute, 1959). Several more fugitive references are given in Stone, *op. cit.*

that the economy of the Pacific Northwest is closely related to the growth of California. The export of electricity from the Pacific Northwest, and perhaps even water at some future date, might assist in the growth of California. This induced growth of California would, through a series of interindustry relations, affect the structure and character of growth in the Northwest. But how much? An input-output analysis would assist in studying this induced growth.

A number of studies have been made for urban areas. On occasion input-output coefficients for the national economy have been used as if they applied directly to the urban area. On other occasions, new input-output coefficients have been computed for the subject urban area. In both cases, it is possible to see some of the interrelations between the urban area and the nation. When new input-output coefficients are developed, it is possible to see some of the differences in structure between the urban economy and the national economy. These differences may be great.[14]

2. *Multiregion Studies.* A number of interesting studies have been made using input-output tables recognizing several regions.[15] Output of all commodities is divided up among regions and industries within regions and the same is done for inputs. A regional input-output table for a nation, for example, permits the study of between-region flows resulting from interindustry interdependences and growth or decline in regions resulting from changes in demand. Strategy in table construction may vary greatly. Leontief has suggested dividing industry into national and local categories and studying regional reaction to changes in the outputs of national industries.[16] More complex models are required for the study of interregional relationships and national reaction to changes in regional output.[17] Regional studies might also differ greatly in level of regional or industry aggregation.

In addition to problems of industry classification, assumptions regarding input-output coefficients, and so on, recognized earlier, regional input-output studies are characterized by several distinct problems of their own. One is the sheer size of the undertaking. A 50-industry ten-region input-output model of the United States would require a matrix of input-output coefficients 500 × 500, or obtaining data for some 250,000 coefficients. Another computational problem is that for the same degree of industry identification, a multiregion model involves many more equations than a single-region model. With the advent of large computers this problem is becoming manageable.

It may or may not be difficult to assume that input-output coefficients are invariant for different levels of production. If the range of final outputs for which an input-output system is studied does not vary greatly from the level at which the input-output coefficients were computed, then the assumption of invariancy would not be difficult to make. In interregional input-output a similar sort of assumption must be made regarding the

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[14] See the tables in Hirsch, *op. cit.*, and Hoch, *op. cit.*

[15] Walter Isard, "Interregional and Regional Input-Output Analysis: A Model of a Space-Economy," *Review of Economics and Statistics*, Vol. 33 (November, 1951), pp. 318–28, and "Regional Commodity Balances and Interregional Commodity Flows," *American Economic Review*, Vol. 43 (May, 1953), pp. 167–80; Walter Isard and Robert A. Kavesh, "Economic Structural Interrelations of Metropolitan Regions," *American Journal of Sociology*, Vol. 60 (September, 1954), pp. 152–76; Walter Isard and Robert E. Kuenne, "The Impact of Steel Upon the Greater New York-Philadelphia Industrial Region: A Study in Agglomeration Projection," *Review of Economics and Statistics*, Vol. 35 (November, 1953), pp. 289–301; Hollis B. Chenery, "Interregional and International Input-Output Analysis," chapter in *The Structural Interdependence of the Economy*, *op. cit.*, pp. 339–56; Robert A. Kavesh and James B. Jones, "Differential Regional Impacts of Federal Expenditures: An Application of the Input-Output Matrix to Federal Fiscal Policy," *Papers and Proceedings, Regional Science Association*, Vol. 2 (1956), pp. 152–67; Leon N. Moses, "The Stability of Interregional Trading Patterns and Input-Output Analysis," *American Economic Review*, Vol. 45 (December, 1955), pp. 803–32; and Hollis B. Chenery, Paul G. Clark, and Vera Cao Pinna, *The Structure and Growth of the Italian Economy* (Rome: U. S. Mutual Security Agency, 1953), pp. 97–130.

Some of these studies (Isard and Kuenne, and Kavesh and Jones) might be classed with those in note 13. These are two-region models where chief attention is given to one of the regions.

[16] Leontief, *Studies in the Structure of the American Economy*, *op. cit.*, pp. 93–115.

[17] For example, Isard, "Interregional and Regional Input-Output Analysis . . ," *op. cit.*

invariance of regional trading patterns. One might have, for example, a set of interregional input-output coefficients obtained for a given level of production and consequent interregional relations. The level of final demand changes. This might well change interregional trading paths. One region may not buy from another at a particular level of output but as demands increase, flows may begin between the two regions. Moses has indicated ways of attacking this problem directly by showing clearly how interregional input-output coefficients are derivable from sets of interindustry relations and sets of interregional trade coefficients.[18] Moses' arrangement makes practicable the study of interregional trading paths apart from interindustry coefficients and vice versa.

An examination of the several studies that are available will reveal that interregional input-output provides a very flexible method of approach. Investigators may start with somewhat different purposes, different types of data, and different problems. The exact form of the model may then be chosen to reflect the purposes and resources available. Identification of industry sectors, and handling of capital formation and exports and imports may all be varied to suit the problem at hand.

3. *A Migration Model.* A good example of applying a format developed for one problem to another is provided by Lövgren's use of an input-output arrangement in studying migration between districts in Sweden.[19] The study also provides a sample problem in input-output and may clarify some of the points above. Lövgren observes that migration involves a complex series of circulations. In Sweden, for example, it has been observed that migration from various districts to Stockholm is associated with a complex set of in- and out-migrations among districts (Fig. 5).

Such migration flows may be set down in the input-output format and coefficients computed. Lövgren has provided fictitious coefficients for a multi-region system (Table 1) and a solution to the proposition that 100

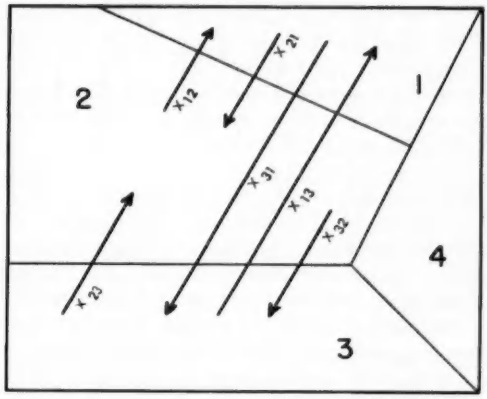

FIG. 5. Migration currents between three areas. After Lövgren, p. 161.

persons migrate from region 3 to region 4 (Table 2). The structure of migration currents is such that 132 persons leave region 3, 32 bound for regions other than region 4. At the same time, 80 persons moved into region 3 from regions 1 and 2.

These results were obtained in the following manner: First, observe that migration relations of Figure 5 may be expressed in equations (4):

$$\begin{aligned} X_1 - x_{21} - x_{31} &= 0 \\ -x_{12} + X_2 - x_{32} &= 0 \\ -x_{13} - x_{23} + X_3 &= 0 \end{aligned} \tag{4}$$

The first equation states, for example, that total out-migration from region 1, X_1, minus the out-migration from region 1 to region 2, x_{21}, minus the out-migration from region 1 to region 3, x_{31}, is equal to 0. Migration coefficients were defined using equation (5)

$$a_{ik} = \frac{x_{ik}}{X_i} \tag{5}$$

yielding equations (6).

$$\begin{aligned} X_1 - a_{21}X_2 - a_{31}X_3 &= 0 \\ -a_{12}X_1 + X_2 - a_{32}X_3 &= 0 \\ -a_{13}X_1 - a_{23}X_2 + X_3 &= 0 \end{aligned} \tag{6}$$

Lövgren's proposition was that 100 persons migrate from region 3 to region 4. Placing this information together with the fictitious coefficients of Table 1 in equations (6) achieves equations (7).

$$\begin{aligned} X_1 - 0.2X_2 - 0.3X_3 &= 0 \\ -0.4X_1 + X_2 - 0.3X_3 &= 0 \\ -0.5X_1 - 0.1X_2 + X_3 &= 100 \end{aligned} \tag{7}$$

[18] Moses, *op. cit.*

[19] Esse Lövgren, "Mutual Relations between Migration Fields: A Circulation Analysis," *Proceedings*, Symposium on Migration in Sweden (Lund Studies in Geography, Ser. B. Human Geography, No. 13, 1957), pp. 159–69.

TABLE 1.—FICTITIOUS MIGRATION COEFFICIENTS[1]

Out-migration from—	In-migration to region—		
	1	2	3
1	—	0.2	0.3
2	0.4	—	0.3
3	0.5	0.1	—

[1] From Lövgren, p. 161.

TABLE 2.—MIGRATION BETWEEN AREAS 1, 2 AND 3 IF 100 PERSONS MIGRATE FROM AREA 3 TO AREA 4[1]

Out-migration from—	In-migration to region—				Total out-migration
	1	2	3	4	
1	—	12	40	0	52
2	21	—	40	0	61
3	26	6	—	100	132

[1] From Lövgren, p. 162.

Solution of these equations for the X's and applying the migration coefficients of Table 1 and relation (5) yields the results in Table 2.

This is an extremely simple example of a one-industry (say, labor) three-region model. (Again, one might term this a four-region model. Three regions are specifically identified. The fourth region plays a role analogous to final demand in the ordinary input-output format.) It should be noted that this operation is somewhat more uncertain than the ordinary input-output operation. A great deal has been said elsewhere regarding the assumptions underlying the computation of input-output when coefficients are computed for industry flows. Similar analyses have not been made for the computation of migration coefficients.

Lövgren has worked with a ten-region model of Sweden and studied the effect of flows to an additional region, Stockholm, on migration among the ten regions. In Sweden data are available for a comparison of migration coefficients from year to year and Lövgren has done such comparative work. Although this work is very exploratory, Lövgren concludes that this type of circulation analysis is superior to more traditional methods.

Interregional Linear Programming

Input-output is an established analytic procedure for studying single areas, and interregional input-output is well on its way to acceptance as a standard method of analysis. Interregional linear programming is following hard on the heels of input-output techniques and, indeed, shows promise of eclipsing input-output analysis. A linear programming model may be constructed from an input-output model without too much difficulty, and the results of the linear programming analysis are quite a bit richer than those of an input-output analysis.

The reader will recall that the typical linear programming problem involves something to be maximized or minimized and a set of constraining equations. Equations (3) may be turned into a set of constraining inequalities simply by substituting inequalities for the equalities. In the first equation, for example, the left-hand side might be required to be greater than or equal to the final demand from that industry, C_1. This would assure that the total amount produced, X_1, minus the amounts shipped to other industries would be at least equal to and could be greater than the amount demanded. If one of the equations in the set of equations (3) referred to the use of labor, the inequality would run the other way. That is, one would require that the amount of labor used in various industries not exceed the total amount available. The input-output equations of (3) could be augmented by a whole series of equations requiring that the drawdown of various resources not be greater than the amount of each resource available.

The remarks above accomplish the transformation of an input-output format into a linear programming format, except for deciding what is to be maximized or minimized and this requires distinguishing between intermediate and final products. The variables X_i refer to gross production. One might want to maximize the sum of these values weighted by their prices. But a more likely problem would require that the value of net output be maximized. That is, treat the C_i's as variables and maximize their sum when weighted by their prices.

Problems may be written several ways to accomplish the latter objective. In general, the constraining equations would display interindustry relationships, require that resources used in production processes not exceed those available, and require that net output of certain or all commodities reach some minimum level(s). Two sorts of var-

iables might be recognized: intermediate and final commodities. In some cases a commodity may appear as a resource, an intermediate commodity, and as a final commodity. Coal is an example of such a commodity.

This adds up to the observation that the researcher's choice is very wide in the formulation of an interregional linear programming problem as well as in the formulation of interregional input-output problems.[20] Not only does one have wide choices of industry classifications and constraints, but opportunity for choice extends to the objective function which expresses what is to be maximized or minimized. It was remarked before that one possibility is to maximize the value of the final goods produced. Prices would be determined outside the model and the amounts of radios, automobiles, etc., would be chosen according to the rule that the mix of maximum value be produced. Because prices are tied in some manner to quantities, it may seem somewhat artificial to take prices as given regardless of quantities. Beckmann and Marschak handle this by couching an interregional linear programming problem in terms of vector maximization, i.e., to characterize that set of vectors that satisfies the constraints so that each vector in the set is larger with respect to some component than another vector in the set only if it is smaller with respect to a different component.[21] Another way to handle this problem is to set down some artificial prices based on interregional price differences resulting from interregional transport costs and explore solutions using these prices. An even more general approach would require enlarging the problem to include finding the amount and location of all production and consumption and all prices.

General interregional linear programming is more on the horizon than it is an accomplished fact. Two restricted empirical studies are available in the literature, however.

1. *Petroleum Refining.* Marschak has made an interregional programming study of the petroleum refining industry, based on an earlier study by Manne.[22] Marschak broke down Manne's national model into four regions—Gulf, Midwest, East, and West—and introduced transportation activities within and between regions. Manne's model contained 105 equations. In order to represent technology in each of the four regions without using 420 equations, Marschak reduced Manne's model to 39 equations. The 39 equations in each of four regions together with equations covering transportation gave 195 equations in Marschak's model. There were 1,555 variables in the regional problem.

Marschak did some computing with his model. Data for 1952–53 were placed in the model and the final product mix maximized. Marschak found that nearly as much could be produced without interregional shipments of intermediates as could be produced with interregional shipments. Particular attention was focussed on the effect of transportation bottlenecks on production. As would be expected, Marschak found that with efficient use of transportation there is a great excess of tank cars and tankers. When the amount of tanker shipping space available is arbitrarily reduced, tank car and pipeline transportation is substituted for tankers and at the one hundred tanker level all tank car and pipeline capacity is used. The availability of transportation also affects the productive capacity of the industry (Figure 6).

Marschak emphasized that his model is highly exploratory and that there may be some errors in the transportation coefficients used. He does stress, however, that his model solves problems which may not be solved by "back-of-the-envelope" calculations.

[20] For examples of model construction see: Walter Isard, "Interregional Linear Programming: An Elementary Presentation and a General Model," *Journal of Regional Science*, Vol. 1 (Summer, 1958), pp. 1–59; Benjamin H. Stevens, "An Interregional Linear Programming Model," *Journal of Regional Science*, Vol. 1 (Summer, 1958), pp. 60–98; Benjamin H. Stevens and Robert E. Coughlin, "A Note on Inter-Areal Linear Programming for a Metropolitan Region," *Journal of Regional Science*, Vol. 1 (Spring, 1959), pp. 75–83; and Edward B. Berman, "A Spatial and Dynamic Growth Model," *Papers and Proceedings*, Regional Science Association, Vol. 5 (1959), pp. 143–150.

[21] Martin J. Beckmann and Thomas Marschak, "An Activity Analysis Approach to Location Theory," *Proceedings*, Second Symposium in Linear Programming (Washington: National Bureau of Standards, 1955), p. 367.

[22] Thomas A. Marschak, "A Spatial Model of U. S. Petroleum Refining," U. S. Air Force, Project RAND, Research Memorandum, RM-2205, June 1958, and A. S. Manne, "A Linear Programming Model of the U. S. Petroleum Refining Industry," *Econometrica*, Vol. 26 (January, 1958), pp. 67–106.

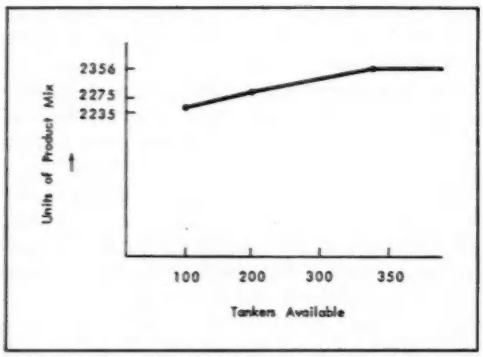

FIG. 6. Output and Tankers. An increase in the number of tankers (standardized on type T-2 tanker) available increases the capacity of the petroleum refining industry. After Marschak, p. 84.

2. *Land Utilization.* Henderson has proposed two models of the utilization of agricultural land and has done empirical work with one of these. One is an extension of the model used in Henderson's study of coal flows discussed in Part II of this essay.[23] This problem differs from the transportation problem used for the study of coal flows, however, in that there are several commodities and that the costs of delivery to be minimized include both transportation costs and cultivation costs. Since there are several crops, there are sets of demand requirements for each crop. Each region has capacity restrictions on the amount of land available.

In Henderson's second model, interregional flows are not treated directly.[24] The farmer's decision problem is taken to be the choice of land utilization. The farmer selects a land utilization pattern which maximizes his expected net revenue, the difference between the prices he expects to receive for his crops and his costs. The farmer's utilization of land is constrained by his inability to use more land for his crops than is available on the farm, and by his short-run "stickiness." Henderson states that farmers do not make drastic changes in land utilization from year to year; instead their changes are rather gradual. Also, government-imposed acreage allotments fix maximum allotments for certain types of crops. "Stickiness" is introduced into the programming format by constraining the amounts of land devoted to individual crops within limits close to traditional limits or within limits imposed by acreage allotments.

Henderson implemented the model in two cases for the 1955 crop year. Instead of considering individual farms, regions were used as decision-making units, and each region was treated as if it were a farm. In one case 160 separate areas were recognized, of which 23 were areas where irrigation farming was important. The irrigation farming areas overlapped 28 of the total areas. A smaller model was also developed. This recognized 43 dry-farming areas plus 12 irrigation-farming areas. In this case, the 12 irrigation-farming areas were coexistent with 12 of the 43 dry-farming areas. Both the 160 and the 55 region models were operated using data on 11 field crops. Altogether, these 11 field crops accounted for two-thirds of the value of all United States' field crops. It was necessary to have knowledge of cost and expected prices, acreage allotments, expected yields and so on, in order to implement the model. These data were developed from a variety of standard sources, and coefficients which constrained the range of selectable amounts of acreage were calculated.

Results for each region were computed separately; so the results from each model represented the composite of 160 or 55 separate computations. The results of Henderson's computations were compared with "naïve" estimates produced by using 1954 data as the estimate of 1955 conditions. The results were also compared with land utilization estimates prepared by the Crop Reporting Board of the

[23] James M. Henderson, *The Efficiency of the Coal Industry* (Cambridge: Harvard University Press, 1958), pp. 133–7.

[24] James M. Henderson, "The Utilization of Agricultural Land: A Regional Approach," *Papers and Proceedings*, Regional Science Association, Vol. 3 (1957), pp. 99–117, and "The Utilization of Agricultural Land: A Theoretical and Empirical Inquiry," *Review of Economics and Statistics*, Vol. 41 (August, 1959), pp. 242–59. Other studies of agriculture include Robert Koch and Milton M. Snodgrass, "Linear Programming Applied to Location and Product Flow Determination in the Tomato Processing Industry," *Papers and Proceedings*, "Regional Science Association, Vol. 5 (1959), pp. 151–62, and Milton M. Snodgrass and Charles E. French, *Linear Programming Approach to the Study of Interregional Competition in Dairying* (Lafayette, Indiana: Purdue University Agricultural Experiment Station, 1958). For a method of studying land utilization in urban areas see Stevens and Coughlin, *op. cit.*

U. S. Department of Agriculture. The large regional model was better than the small and both models seemed better than naïve estimates. Crop Reporting Board estimates were better than those produced by Henderson's small model, but apparently not as good as those of his large model. It is difficult to compare the efficacy of one estimating device versus another, especially where the devices are prepared in different formats. In this case the comparison seems to have been arranged so as to favor the Crop Reporting Board estimates. Had a more even comparison been possible, the superiority of Henderson's large model might well have been more marked.

Industrial Complex Analysis

Industrial complex analysis is a term used by Isard.[25] It refers to the analysis of a complex of industries within which interindustry relations may be clearly recognized and to the use of a variety of analytic tools. Much research in this field could be termed industrial complex analysis, if a catholic interpretation is given the term, because much research requires use of several analytic devices and reduction of a problem to an industry (complex). For example, Part II of this essay discussed Wester and Kantner's combining of a transportation-type problem with the Weberian location problem and a simple allocation problem to find locations for warehouses.[26] Also, Henderson's land-use problem discussed above utilized both a linear programming formulation and certain simple calculations to determine limits within which land uses might change.

This essay does not attempt to cover all the analytic tools for making an industrial complex analysis. The range of available tools includes simple cost accounting, potential models, localization indices, and other widely used techniques. As mentioned before, these topics have been omitted from the present essay although some are subjects of interesting current research. Our attention will be limited to two recent examples of industrial complex analysis.

1. *Petroleum Refining, Petrochemicals, and Synthetic Fibers in Puerto Rico.* The refining-petrochemical-synthetic fiber complexes were the subject of a recent industrial complex analysis by Isard, Schooler, and Vietorisz.[27] The authors present some of the technical interrelations of these truly complex industries in the flow-sheet showing how over 50 products emerge, mostly through a series of intermediate products, from the raw materials, natural gas and crude oil (pp. 30–31). These products range from gasoline through plastics to fertilizer. In many cases, of course, still other industries, such as the textile industry, use these end products as their raw material.

The purpose of the analysis was the evaluation of regional advantages of Puerto Rico for the industry. This required recognition of variations in cost from place to place in the mix of capital, labor, and other inputs used by the industries, as well as variations in prices received for the finished products over the range of alternative product mixes. Also, it was necessary to trace economies of scale resulting from variations in sizes of manufacturing plants and other types of economies.

Reviewing works where the authors deal with so many considerations is truly the reviewer's despair. There are so many facets to such a study that it is practically impossible to cover them adequately without reproducing the whole work. Roughly this is what was done: Different production programs or industrial complexes were considered for location in Puerto Rico. These considerations sifted the feasible production programs down to a handful, and detailed analysis of all the

[25] No doubt the term is not original with Isard. For a discussion of industrial complex analysis see Walter Isard and Thomas Vietorisz, "Industrial Complex Analysis and Regional Development," *Papers and Proceedings*, Regional Science Association, Vol. 1 (1955), pp. U1–U17, and Walter Isard and Eugene W. Schooler, "Industrial Complex Analysis, Agglomeration Economies and Regional Development," *Journal of Regional Science*, Vol. 1 (Spring, 1959), pp. 19–33.

[26] Leon Wester and Harold H. Kantner, "Optimal Location-Allocation," paper read at the Boston Meeting, Operations Research Society of America, 1958 (Chicago: Armour Research Foundation of Illinois Institute of Technology, mimeographed, 1958).

[27] Walter Isard, Eugene W. Schooler and Thomas Vietorisz, *Industrial Complex Analysis and Regional Development* (Cambridge: Technology Press of the Massachusetts Institute of Technology; New York: John Wiley and Sons, Inc., 1959), and Walter Isard and Eugene W. Schooler, *Location Factors in the Petrochemical Industry* (Washington: U. S. Department of Commerce, 1955). Chief reference is to the former.

costs of each of these programs was then undertaken. The end result of this detailed analysis is a recognition of alternative production patterns which could be defined as efficient for Puerto Rico. It was concluded that Puerto Rico has advantages over all other areas for certain types of refining-petrochemical-synthetic fiber production systems. In particular, local advantage was found for a complex comprising the production of dacron A, petroleum refinery fertilizer production, and an associated synthetic fiber plant. Compatible technical processes, low labor costs, and the fertilizer market in Puerto Rico combine to provide the advantage for this complex.

2. *Synthetic Fibers.* Airov has studied the locational advantages in several regions for the synthetic-fiber industry.[28] He began by projecting demands for synthetic fibers; he then examined alternative location choices for the investment needed to meet the demands. The industry complex splits several ways in locational choices. Choices may be made between raw material producing areas for investment in expanded raw material production; chemical intermediate and end product fiber production require choices between raw material and market locations. There are also choices involving size of plant, product mix, etc.

The hydrocarbon and chemical raw materials of the industry are effectively limited to the Texas-Gulf Coast area and the West Virginia area; markets are in the textile manufacturing areas of New England, the Middle Atlantic, and the South. Airov's detailed analyses of costs lead to the conclusion that most of the intermediate capacity will be located in the Texas-Gulf Coast area with exception of the production of nylon salts, much of which will be produced in the textile region of the South. Lowest cost for synthetic fiber production as an end product is found in the market regions, especially the South and Puerto Rico.

There are many things that may be said for industrial complex analysis. It is no-holds-barred analysis stressing interrelations between variables and using all analytic resources available. It is hard to see how anything could be done better. Intuition plays a role, of course, but seems reasonably well confined to the efficient formulation of the problem and selection of tools. Reliance on intuition is minimized in places where it might lead to errors, such as in choosing levels of activities within a complex.

General Spatial Equilibrium

Nearly everything that has been discussed to this point in this essay is often subjected to the criticism that the analyses are overly restricted and use models which do not reveal the Kantian "essence" of things. The latter criticism is inappropriate. More to the point is the comment that the models are restricted, certain things are taken as given and fixed and the problem is limited to a few variables. Although it is proper to question whether a variable is determined within the problem or is taken as given, this does not mean that models using fixed elements are of no value. Indeed, it is hard to see how one could do work of any sort with systems where everything conceivably related to the problem is subject to change. There are advantages in recognizing explicitly just what variables are being studied and which are not. The alternative is to attempt to study a completely variable system, which in practice means looking at variables one at a time or otherwise constraining the study, perhaps unknowingly.

There is one other comment about the models which is appropriate. How does one know that *in toto* the considerations of the model or the broad system represented by the model represent some workable system? Is the model internally contradictory or does it, however imperfectly it is formulated, resolve the problem to which it is addressed? Does it have a solution? Is the character of the solution consistent with the processes which the model displays (e.g., the market in a competitive economy)? Knowing whether or not equilibrium exists in a system and recognizing conditions under which it might exist, throw a great deal of light on the consistency and completeness of the statements that go into the model.

Equilibrium in economic models has been a subject of continued study, building on

[28] Joseph Airov, *The Location of the Synthetic-Fiber Industry* (Cambridge: Technology Press of the Massachusetts Institute of Technology; New York: John Wiley and Sons, Inc., 1959).

Walras' treatment of equilibrium. The Walras-like equilibrium systems treat a world without spatial properties. Questions of flows of commodities among regions, prices of transportation services, comparative advantage, choice of location, urbanization, and the like all lie outside these systems. In other words, the problems treated by the spatially-oriented models discussed in this essay lie for the most part outside the classical considerations of economic equilibrium.[29]

Interest in equilibrium in models that stress locational characteristics emerged with the gradual development of location theory. Lösch raised the question of the existence of a solution for his location system, as noted in Part I of this review. The few pages in which Lösch discusses this problem present a succinct summary of just what Lösch did and did not accomplish.[30] The existence of an equilibrium solution to Lösch's model is an open question. Lösch claims that he presents a complete system inasmuch as there are as many variables in the system as there are equations; so there is a solution. But this counting of equations and variables is not enough to guarantee a meaningful solution.

Isard considered both partial and full equilibrium in his *Location and Space Economy*. As was the case in Lösch's volume, Isard's comments on equilibrium, especially those in his mathematical chapter, are a succinct statement of his system.[31] Actually Isard does not claim his system is completely general. It seems to this reviewer that it neglects the demand and price sides of a completely general problem.

Recent works have dealt with general models which are related to the models discussed previously in this part of this essay.

McKenzie has treated the special case of comparative advantage in international trade models.[32] Comparative advantage as it has been classically treated has been a rather restricted notion. Several countries trade. According to the principle of comparative advantage some activities are suppressed and others stressed within each nation, the result being patterns of specialization which are efficient on an international scale. Is this true? McKenzie has generalized the comparative advantage principle so that it indeed covers many countries and many kinds of activities, and has shown that competition and free trade will lead to an efficient overall pattern of production within the concepts and variables specified by the model. While McKenzie's work is interesting and some of his findings and approaches are very pertinent to the construction of equilibrium models, his is not quite the same as any one of the problems revealed by the previous models. Transportation costs and patterns, which were eliminated from McKenzie's work, are very much at the heart of the models in the preceding discussion.

Lefeber has recently published a monograph on the topic of general spatial equilibrium analysis.[33] The problem is divided into several parts. Transportation is stressed throughout the analysis and the method of treatment of transportation is discussed early in the first part of the discussion. The remainder of the first part treats the location of production. Both the classical approach

[29] A good introduction to the equilibrium problem is Walter Isard's "General Interregional Equilibrium," *Papers and Proceedings*, Regional Science Association, Vol. 3 (1957), pp. 35–60. Walter Isard and David J. Ostroff have placed certain current equilibrium problems in economics in a regional context in "Existence of a Competitive Interregional Equilibrium," *Papers and Proceedings*, Regional Science Association, Vol. 4 (1958), pp. 49–76, and "General Interregional Equilibrium," *Journal of Regional Science*, Vol. 2 (Spring, 1960), pp. 67–74.

[30] August Lösch, *The Economics of Location*, translated from the second revised edition by William H. Woglom with the assistance of Wolfgang F. Stolper (New Haven: Yale University Press, 1954), pp. 92–100.

[31] Walter Isard, *Location and Space Economy* (Cambridge: Technology Press of the Massachusetts Institute of Technology; New York: John Wiley and Sons, 1956), pp. 221–53.

[32] Lionel W. McKenzie, "Specialization and Efficiency in World Production," *Review of Economic Studies*, Vol. 21 (1953–4), pp. 765–80, and "On Equilibrium in Graham's Model of World Trade and Other World Systems," *Econometrica*, Vol. 22 (April, 1954), pp. 147–61. Also, T. M. Whitin, "Classical Theory, Graham's Theory and Linear Programming," *Quarterly Journal of Economics*, Vol. 67 (November, 1953), pp. 520–44.

[33] Louis Lefeber, *Allocation in Space* (Amsterdam: North-Holland Publishing Company, 1958). Also, "General Equilibrium Analysis of Production, Transportation and the Choice of Industrial Location," *Papers and Proceedings*, Regional Science Association, Vol. 4 (1958), pp. 77–86.

and programming formulations are presented. The second part of the discussion merges distribution and production and treats their mutual equilibrium. The final part of the discussion merges the choice of industrial locations with the analysis of production and distribution. Programming methods are used widely through Parts II and III of the discussion. Lefeber's discussion is liberally augmented by miniature numerical examples and by expository introductions and summaries. The final chapter covers a series of related topics including notes on investment problems, treatment of transportable and nontransportable factors, and so on. The appendix gives a short statement of the complete system.

Equilibrium in models is a fascinating subject. But it is a highly technical subject and it is not easy to give a bird's eye view of studies and their accomplishments. As mentioned before, the studies provide succinct summaries of general systems. Also, the studies show the conditions under which economic systems are solved by market mechanisms. It is easy to see how partial spatial equilibrium is achieved.[34] General spatial equilibrium, such as that analyzed by Lefeber, requires consideration of many industries and regions, and equilibrium considerations are more complex. Equilibrium is an open problem when indivisibilities of locations and productive processes are features of the system.[35]

SUMMARY AND FORECAST

This essay began by summarizing a half-dozen books written or published in the early 1950's. Each of these books relied heavily upon a long but relatively small stream of interest in location problems on the part of economists. Each work added to concept and practice in the analysis of location problems. Relatively speaking, the books were long on conceptual implications and short on implications for analysis.

The materials appearing in the literature more recently stand in marked contrast to these benchmark books. Recent additions to the literature have been more specialized, excepting Lefeber's general volume. Also, they have been rich in both concept and in implications for analysis. There are two overriding concepts from those articles and monographs that have been discussed. First is the concept of the location system as a *combination of interrelated activities* at different places. Some activities are suppressed and others are carried on at a variety of levels according to constraints of resource availability, capacities of man-made facilities, technical interrelations, and so on. Second, the concept of the location system as a system of activities makes clear the role of market forces, rents, and so on, on the one hand, and the physical patterns of flows and production on the other. This is achieved through the concept of duality, using notions from activity analysis. This allows one to enlarge the concept—we may think of the location system as a pattern of *efficient* combinations of activities at different places. The word "efficient" arises from the economic pressures operating on the problem: something is maximized or minimized.

The richer the concept the greater is the challenge to implement it. Implementation has been emphasized over and over again in the latter portions of this essay. These portions of the essay have demonstrated that the researcher has a large number of building blocks from which to tailor a device to implement his study of a problem. The approaches that have been mentioned here, together with other well-known approaches and appropriate statistical and data-processing tools, give a power to analysis that is immeasurably greater than what has been available before.

Lest it may seem that we are claiming too much, it might be wise to remark that these developments are what one would expect. The growth of the sciences in the past few years has been so rapid that explosion is to be expected. Paralysis and stagnation are unexpected.

What of the next decade? Apart from the obvious forecast of continued rapid development of this area of knowledge, this writer will make two predictions based on two

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[34] *Equilibrium of a single industry.* See the discussion of spatial price equilibrium in Part II of this essay.

[35] This is the Koopmans and Beckmann problem discussed in Part II of this essay. See Tjalling C. Koopmans and Martin Beckmann, "Assignment Problems and the Location of Economic Activities," *Econometrica*, Vol. 25 (January, 1957), pp. 53–76.

needs. There is good evidence that the tools of analysis have rapidly outstripped their raw material. An analysis of regional growth and development in the United States using a fine-grained interregional linear programming model is conceptually practicable, and with the rapid advance in computer technology would be physically practicable in the near future. But where are the raw materials for such an analysis; where are the data? Our analytic devices have outstripped the data to feed them. This need will direct more attention to developing new data sources and improving the data already available.

There is another major need. Nowhere is there a single summary volume bringing together the methods of analysis developed in the last few years and described in part in the latter portions of this essay.[36] Such a volume would have great pedagogical value and would be a must for the analyst's bookshelf. It is not difficult to forecast that this need will be met in the very near future. When this essay was in final draft I had the privilege of seeing the galley proofs of Professor Walter Isard's new book, *Methods of Regional Analysis*.[37] The topics covered in this essay, and more, are covered in this new volume. This field owes much to Walter Isard. Through his research, his organizational energies, and his ability to interest students and others, he deserves much of the credit for recent accomplishments in regional analysis. His *Methods of Regional Analysis* promises to be another major contribution.

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University of Washington
and Northwestern University

[36] This is not completely true. See Claude Ponsard, *Économie et Espace: Essai d'intégration du facteur spatial dans l'analyse économique*, Observation économique, Collection publiée sous la direction de André Piatier, Vol. VIII (Paris: Sedes, 1955), and Olaf Boustedt and Herbert Ranz, *Regionale Strukturund Wirtschaftsforschung, Aufgaben und Methoden* (Bremen: Walter Dorn, 1957) reviewed in Part I of this essay.

[37] Forthcoming in the Regional Science Series (Cambridge: Technology Press of the Massachusetts Institute of Technology; New York: John Wiley & Sons).

THE *ANNALS* MAP SUPPLEMENT

A "Map Supplement" to the *Annals*, approved by the Council in 1957, was announced in the March issue of the *Annals* for 1958. This statement reads in part:

> The objective is to provide a publication outlet in the Association for the cartographic portrayal of geographic data on a format larger than *Annals* page size. The Council is convinced that maps dealing with particular areas or subjects can be made to stand alone, requiring little or no explanatory text.

The Council indicated that only maps of the highest quality should be given consideration. Please note that quality refers both to research significance and excellence of execution. Methodological items requiring large format will be given consideration if sufficiently broad in their application. The Map Editor is authorized to accept or reject maps and, if the author has been unsuccessful in soliciting funds to cover publication costs, will attempt to obtain funds for maps he accepts. This applies to expensive multi-color maps as well as those in black and white.

On the reverse of this page, which shows the exact maximum size of a fold-unit, will be found scale diagrams of the possible arrangements up to 16 pages. Folded, a 16-page map printed on roadmap stock will total about $^{3}/_{32}$ inches (2.4 mm) in thickness and is close to the practical limit for inserts. The map supplements will not necessarily be to these maximum sizes—but it is desirable that the fold-unit be kept roughly to the proportions indicated—otherwise an awkward insert will result. Note, on the upper right-hand diagram—as well as on the 8-page diagram below—the size of the *National Atlas* page. This shows the relation of the Map Supplement proportions to the Atlas page and the considerable lack of accommodation between them.

Anyone contemplating an entry should make his ideas known to the Map Editor in the early stages of his project. Do not wait until your plans have crystallized because technical requirements and limitations might be in conflict with your ideas. The Editor will be glad to furnish advice regarding layout, projections, and preparation of copy for the engraver. Initial proposals should include all known specifications and a sketch layout at reproduction size. Address all submissions and inquiries to:

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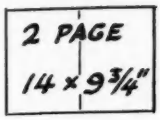

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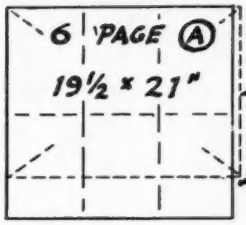

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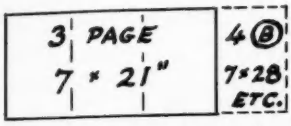

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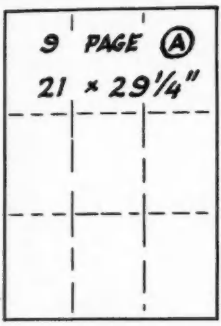

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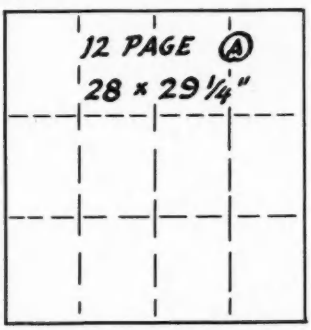

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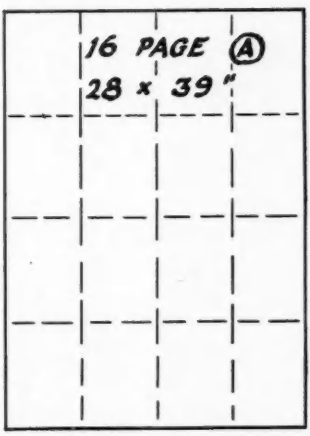

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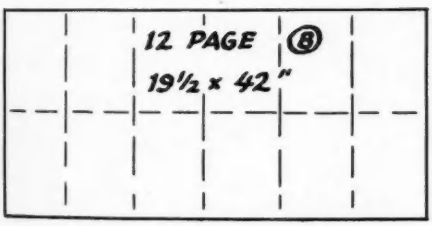

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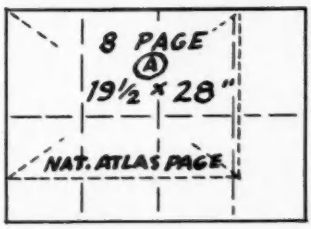

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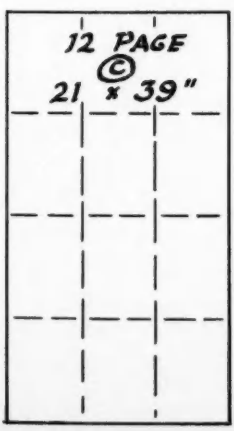

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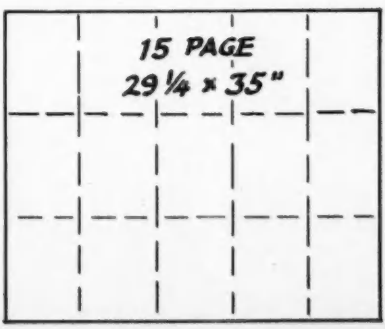
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